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ABSTRACT

Volume II of a 3-volume report demonstrates the use of Design Determinants and Options (presented in Volume I) in the planning and design of small rural Alaskan secondary schools. Section I, a checklist for gathering site-specific information to be used as a data base for facility design, is organized in the same format as Volume I, which can be used as a reference. Section 2 demonstrates the 3-phase design process for a school in a fictitious Alaskan village: (1) Design Determinant Identification indicates the format and type of information required to program the facility; (2) Design Option Selection demonstrates the process of selecting and justifying various alternative systems (such as for the roof or foundation), using the checklist information gathered in phase 1 as a data base; and (3) Schematic Design includes a written description of design retionale as well as schematic drawings of the projected facility and site. The fictitious school used in the example has a construction budget of $1,250,000 and would serve 17 students with a staff of 1 1/2 teachers; the building would be used a great deal after school hours by the community, which is located in a transitional climatic zone and experiences yearly flooding. (SB)

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II. Methodology

An Example Process of Identifying Determinants, Selecting Options, & Developing Schematic Designs

State of Alaska
Rural Schools Prototype Analysis

prepared by CSM INC

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VOLUME II, METHODOLOGY

Rural Schools Prototype Analysis

Prepared For:

State of Alaska
Department of Transportation and Public Facilities
Division of Facility Procurement Policy

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VOLUME II - METHODOLOGY

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PREFACE

The information contained in VOLUME I, DESIGN DETERMINANTS AND OPTIONS, is demonstrated in VOLUME II, METHODOLOGY, as a program and schematic design for an example educational facility.

METHODOLOGY contains two sections:

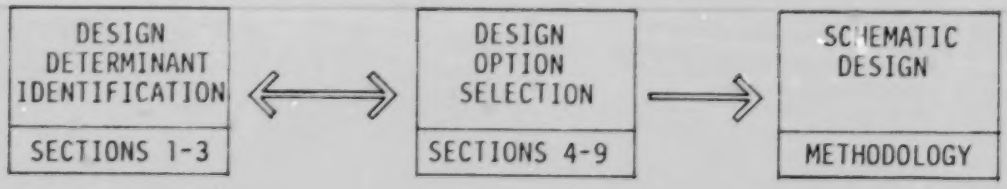
A. CHECKLIST FOR IDENTIFYING DESIGN DETERMINANTS: A CHECKLIST is provided to be used for gathering site-specific information (DESIGN DETERMINANTS). These DESIGN DETERMINANTS can then be used as a data base for determining and evaluating project scope, establishing a program, selecting DESIGN OPTIONS, and developing a SCHEMATIC DESIGN.

B. EXAMPLE PROCESS: The example process is given to demonstrate the use of VOLUME I, DESIGN DETERMINANTS AND OPTIONS, in the design process for a secondary school for the fictitious village of Kuchpu, Alaska.

In section B.1, the DESIGN DETERMINANTS have been identified in a completed CHECKLIST. This is the information that needs to be gathered to begin programming and design of facilities.

In B.2, a process of selecting options is recorded for the prototype school. As the second task of the design process, the designer will select DESIGN OPTIONS (i.e., roof, floor, ceiling, mechanical, electrical systems, etc.). The bank of information (DESIGN DETERMINANTS) gathered in the CHECKLIST can be used as the basis for making decisions between alternative systems such as a forced air versus a hydronic heating system, and piles versus post and pad foundation systems.

In B.3, the selected options are compiled in the text entitled BASIS OF DESIGN, and in DRAWINGS to produce the SCHEMATIC DESIGN for a prototype facility.



An example of the development for on-site generation follows.

EXAMPLE PROCESS: DESIGN DETERMINANT IDENTIFICATION (CHECKLIST)

3.4 ELECTRICAL POWER:

3.41 Availability and Reliability of Utility Power: Commercial power is available from an AVEC (Alaska Village Electric Cooperative) system. The AVEC power plant has two 75 KW and one 35 KW generating units. Distribution is single phase, 7.2 KV underground cable. Service is available from a primary pedestal approximately 150 feet from the new school site. AVEC will install a transformer and service lateral to the new school without charge.

Records indicate power outages of four to five hours per month. Outages usually occur on weekends when the plant is shut down for maintenance. Unscheduled outages due to breakdowns of about three days duration occur about once per year.

EXAMPLE PROCESS: DESIGN OPTION SELECTION

9.4 ELECTRICAL POWER:

9.42 On-site Generation: Cost analysis of various types of on-site generation and purchased power yields the following comparison:

Case 1: Minimum Standby.

Annual cost of purchased power (AVEC)	$17,180
Annualized cost of minimum standby generator (7.5 KW)	525
Total Annual Cost	$17,705

Case 2: Full Standby.

Annual cost of purchased power (AVEC)	$17,180
Annualized cost of standby generator (30 KW)	1,750
Total Annual Cost	$18,930

Case 3: 100% On-Site Generation with waste heat recovery, annualized first cost plus annual operating costs $22,250
Less cost of fuel replaced by W.H. recovery (2,400)

Total Annual Cost $19,850

Owner opted for Case 1, with an advantage of $2,100 per year over Case 3, and approximately $1,200 per year advantage over Case 2.

EXAMPLE PROCESS: SCHEMATIC DESIGN

Standby Generation: The designer has selected a 7-1/2 KW self-contained, skid-mounted, diesel generating unit to be placed in a weatherproof enclosure, and located outside the school.

Standby Load (Mechanical + Minimum Lighting)	6,000 W

A. CHECKLIST FOR IDENTIFYING DESIGN DETERMINANTS

The following CHECKLIST has been created for gathering critical design and programming information. The format for the CHECKLIST is based on Sections 1.0 through 3.0 of DESIGN DETERMINANTS. The DESIGN DETERMINANTS sections can be utilized as a reference for items that should be considered when compiling this information. An example of the information that should be contained in this CHECKLIST is given in this Volume under Section B., EXAMPLE PROCESS, Item 1., Design Determinant Identification, for the design of the secondary school in Kuchpu, Alaska.

Compiling information in the CHECKLIST is the initial task in creating a data base for determining the scope of the project, programming, and design. This data will be a common reference for making and evaluating critical decisions. Information contained in the CHECKLIST might be gathered all or in part by the school district, state, or A/E. The early completion of this task should help identify potential problems in the scope and program phases that will allow adjustments to budget and scope before proceeding into design and contract documents.

The identification of the DESIGN DETERMINANTS will provide the data necessary for the A/E to design a facility that is more responsive to the existing natural and man-made environments, program, and local community.

CHECKLIST

1.0 BUILDING PROGRAM DETERMINANTS:

1.1 Utilization:

1.11 Enrollment _____

1.12 Staffing _____

1.13 Conceptual Teaching Patterns _____

1.14 Educational Specifications _____

1.15 Integration with Existing Educational Facilities and Program _____

1.16 Context of School in Community _____

1.17 Maintenance Technology _____

1.18 Future Expansion _____

1.19 Design Life _____

1.20 Design for the Handicapped _____

1.2 Building Safety:

1.21 Fire Protection:

1.211 Extinguishing Systems _____
1.212 Fire Alarms _____
1.213 Building Materials _____
1.214 Building Location _____

1.22 Freeze-up Protection _____

1.23 Flood Protection _____

1.24 Vandal Protection:

1.241 Site Location _____
1.242 Owner's Perceptions _____
1.243 Budget _____

1.3 Life Safety:

1.31 Fire Protection:

1.311 Extinguishing Systems _____
1.312 Fire Alarm Systems _____
1.313 Building Materials _____
1.314 Exiting _____

1.4 Budget _____
_____

2.0 ENVIRONMENTAL DETERMINANTS:

2.1 Climate: _____
_____

2.11 Latitude, Longitude, and Elevation _____
_____

2.12 Temperature:

Mean Temperature (Winter/Summer) _____
Temperature Extremes (____ deg. F. to ____ deg. F.)
Diurnal Temperature (____ deg. F.)
Heating Degree-Days _____
Freezing Degree-Days _____
Thawing Degree-Days _____
Number of Consecutive Days of Extreme Temperatures ____
Winter Wind Chill Temperatures _____

2.13 Precipitation:

Mean Annual Precipitation _____
Mean Annual Snowfall _____
Maximum Snowfall in 24 Hours _____
Design Snow Load _____
Snowdrifting Characteristics _____

2.14 Wind:

Winter Winds:
Prevailing:
Speed _____
Direction _____
Frequency _____
Storm:
Speed _____
Direction _____
Frequency _____

Summer Winds:
Prevailing:
Speed _____
Direction _____
Frequency _____
Storm:
Speed _____
Direction _____
Frequency _____

Katabatic Wind (As Affects Winter and Summer Winds) _____
_____

Design Windload _____
_____

2.2 Geotechnical and Hydrological:

2.21 Geotechnical:

2.211 Topography _____
_____

2.212 Soils _____
_____

2.213 Permafrost:

Temperatures _____
Ice Content _____

Depth of Permafrost _____
Depth of Active Layer _____
Vegetation _____

2.214 Geology:

Seismic Zone _____
Identification of Acceptable Usable Gravel Sources _____

2.22 Hydrological:

2.221 Flooding and Erosion:

High Water Elevation _____
Graph of Erosion Trends _____

2.3 Logistics:

2.31 Scheduling:

Location _____
Projected Completion Date for Construction _____
Other Construction Projects in Vicinity _____

2.32 Air:

Description of Runway/Landing Characteristics Including:

Length _____
Condition _____
Use Limitation _____

Identification of Applicable Carrier Characteristics:

Size and Type of Carriers (Aircraft) _____
_____
Cargo Size Limitations _____
Schedule Limitations _____

2.33 Water:

Description of Water Transport Systems Available Including:

Identification of Routes _____
Size and Type of Carriers (Ships, Barges, etc.) _____
_____
Cargo Size Limitations _____
Schedule Limitations _____

2.34 Surface:

Description of Land Transport Systems _____

_____

Roads, Trails, etc. Seasonal characteristics, i.e., winter use only, etc., interface with air and water transport systems. Condition of roads and trails and identification of use limitations with regard to size and weight characteristics of carriers.

2.35 Availability and Skills of Local Labor _____

_____

2.36 Availability of Local Equipment:

Condition _____
Ownership _____
Conditions of Use, i.e., Rental, Loan, Sale, etc. _____

_____

2.37 Communications:

Identification of Systems Available _____

_____

3.0 SITE UTILITIES DETERMINANTS:

3.1 Water:

3.11 Existing System _____

_____

3.12 Identification of Potential Sources:

Surface Water _____
Ground Water _____

3.13 Report on Water Quality Characteristics:

Color/Taste/Odor _____
Chemical Content _____
Biological Content _____

3.14 Identification of Water Quantity Available _____

_____

3.15 Water Storage Need _____

_____

3.16 Water Treatment Need _____

3.2 Waste Water:

3.21 Existing System _____
3.22 Quantity and Quality of Waste Water _____
3.23 Soils Condition _____
3.24 Disposal Conditions _____

3.3 Solid Waste:

3.31 Existing System _____

3.4 Electrical Power:

3.41 Availability and Reliability of Utility Power _____
3.42 Cost of Utility Power _____
3.43 Utility Power Voltage Regulation _____
3.44 Utility Power Voltage Characteristics _____
3.45 Cost of Electrical Generation (Both Utility and On-Site) _____
3.46 Logistics _____
3.47 Cold Weather _____
3.48 Soils and Permafrost _____
3.49 Codes _____

3.5 FUEL:

3.51 Existing Facilities:

Code Compliance and Construction _____
Location _____

3.52 Storage Requirements:

Fuel Consumption _____
Fuel Delivery Methods and Schedule _____
Fuel Storage Capacity _____

3.53 Soil Conditions:

Fuel Storage Tank Location _____
Fuel Storage Tank Foundation _____

3.54 Freezing Conditions:

Extreme Temperatures _____
Fuel Pipe Sizing _____

3.55 Environmental Protection:

Dike Size and Construction _____

3.56 Fuel Delivery:

Method of Delivery _____
Unloading Facilities _____

3.57 Fuel Distribution to Buildings:

Routing _____
Protection _____

3.58 Fire Protection Codes:

NFPA No. 30
NFPA No. 31
OSHA
EPA

3.59 Power Requirements:

Power Requirements _____
Power Source _____
Power Distribution _____

B. EXAMPLE PROCESS: THE DESIGN OF A SECONDARY SCHOOL FOR THE FICTITIOUS VILLAGE OF KUCHPU, ALASKA

INTRODUCTION:

For the purposes of illustrating an example of how to use this report for designing a project, we have created Kuchpu, a fictitious village in the Yukon Delta area of Western Alaska.

The EXAMPLE PROCESS is divided into three phases:

1. DESIGN DETERMINANT IDENTIFICATION: This section is a completed CHECKLIST demonstrating the format and type of information required to program a facility. Volume 1, Sections 1.0 through 3.0, was used as a guide for making considerations and generating the assumptions for the Kuchpu facility. Our assumed DESIGN DETERMINANTS were later used as the basis for proceeding with the selection of OPTIONS and development of a SCHEMATIC DESIGN, and also allowed a quick design evaluation in relation to a commonly understood set of criteria.

2. DESIGN OPTION SELECTION: Utilizing the format of Volume I, Sections 4.0 through 9.0, this section provides a demonstration for selecting alternative systems, e.g., roofs: hot, cold, sloped, flat. The documentation of our example selection process used the assumed DESIGN DETERMINANTS to make decisions regarding choices of one system versus another, for example, a roof form is selected by choosing between a cold roof versus a hot roof.

3. SCHEMATIC DESIGN: The designer, at some point in time, must combine the selected OPTIONS, DESIGN DETERMINANTS, and two-dimensional bubble diagrams to produce a three-dimensional schematic design. The SCHEMATIC DESIGN section demonstrates the end product in DRAWINGS. The BASIS OF DESIGN is the written documentation included to describe the design rationale or the combining of data produced in Items 1 and 2, above, and is represented by the DRAWINGS.

B.1 DESIGN DETERMINANT IDENTIFICATION

The initial step in the design methodology is the process of gathering information to be used in the identification of DESIGN DETERMINANTS.

The following is an example of a completed CHECKLIST. For this example, certain items were assumed completed by the school district, and some by the architect. The information compiled in the CHECKLIST is the data base used for the design of the prototype secondary school for the fictitious village of Kuchpu, Alaska, and reflects conditions typical of the Lower Yukon-Kuskokwim Rivers.

1.0 BUILDING PROGRAM DETERMINANTS IDENTIFICATION

1.1 UTILIZATION:

1.11 Enrollment: (17 Students, 11-20 Student Enrollment Group). Presently there are eight secondary students in the village, but we anticipate completion in two years, and we will have 14 students eligible at that time. Projecting five years beyond that, we can justify the possibility of 17-18 students. There is a small village 10 miles to the north, but it has been decided by the school district that they will have their own school. The population in Kuchpu is fairly stable and we do not foresee any dramatic increase caused by immigration or outside development.

1.12 Staffing: One teacher initially, with a part-time aide (or 1/2 time teacher). When enrollment approaches 20, it is planned to add another teacher. One residence will be provided. It is hoped that a husband-wife team can be hired to staff the facility.

1.13 Conceptual Teaching Patterns: While the teachers would prefer traditional classrooms, the need in the village for indoor recreational space has been identified as a higher priority. The architect has been directed by the village and the school district to design a facility that will maximize space in the multipurpose room by using half of that space for an open academic and resource area.

1.14 Educational Specifications: Due to lack of an educational specifications furnished by the school district specific to this site, the information as presented in Section 4.0, Item 4.2, 11-20 Students, is used for this example.

1.15 Integration with Existing Educational Facilities and Program: The new secondary school is to be located on the site of the present elementary school at a distance greater than 20 feet from the existing structure. The secondary school will utilize the food service program provided in the elementary school, and the elementary school will share use of the multipurpose room. The junior high students will take courses in Home Science and Trades and Industries for one period per day, but no additional space for this enrollment is to be provided in the new school.

1.16 Context of School in Community: While an energy efficient and economically designed facility is required, the facility should also be warm, inviting, and cognizant of human scale. It is desired that the main entry to the facility be oriented to the community and readily accessible to the existing elementary school to minimize distance during inclement weather, and provide unobstructed access despite winds and snowdrifting.

It is planned that the facility will be used extensively by all age groups in the community after hours and during the summer. Besides providing space for adult education, the school will be used for meetings, dances, festivals, and community recreation. Durable finishes and quality materials will be specified to accommodate the increased usage.

1.17 Maintenance Technology:

1. Skill Level: It is anticipated that the man currently maintaining the existing elementary school will also be in charge of maintaining the new facility. Another full-time local person will be hired for maintenance. The present man is familiar with the operation of forced-air furnaces and generators. The maintenance record of the existing school has been good. The skill level of the new person, who will be local, is unknown at this time. While energy conservation is important, design for simplicity of maintenance and operation is the number one priority. If the systems go down because of complex controls, then the energy savings will be voided very quickly. Economy of operation will be due to keeping the plant in operation and making the system understandable and accessible for periodic maintenance.

1.18 Future Expansion: Future expansion of the shop and multipurpose room is anticipated to meet local demands. At the same time, if enrollment increases, additional classrooms might be added. Provision will also be made for adding to the mechanical plant.

1.19 Design Life: The new facility will be designed as a permanent institution within the community. This facility should be designed to be used as the core educational and community facility for many years into the future. If water supply is adequate, the owner is interested in sprinklering for both building and life safety. Fire-resistive materials and finishes will be used, and quality hardware, fixtures, materials, and finishes will be specified to reduce effects of wear.

1.20 Design for the Handicapped: A ramp can be designed to give access for potential handicapped people. To make multiple use of this ramp, it should serve as the main access to the building, and provide for ease in delivering supplies and providing access to the shop.

1.2 BUILDING SAFETY:

1.21 Fire Protection:

1.211 Extinguishing Systems: There is currently no public fire extinguishing equipment in the village. The feasibility of an extinguishing system is to be determined for the hazardous areas, e.g., shop, lab, furnace room, after water quantity tests are performed and an initial cost estimate is made.

1.212 Owner desires a fire alarm system.

1.213 Building Materials: One-hour construction must be considered if a second story is developed. Owner requests amortization calculation on extra cost of noncombustible wood construction (fire-retardant treated wood) compared with insurance savings.

1.214 Masterplanning: Location of new secondary school with relation to existing elementary school for wind-borne fire hazard to be considered.

1.22 Freeze-Up Protection:

1.221 Emergency Standby Equipment: Because of unreliable AVEC power, owner desires standby emergency power.

1.222 Owner desires full accessibility to all pipes that may freeze and become damaged.

1.23 Flood Protection: Owner has requested protection based upon the extent of a 30-year flood cycle.

1.24 Vandal Protection: The village experiences very little vandalism. Selection of plumbing fixtures and building utility systems security are the owner's highest priority with regard to vandalism. Excitement for a new secondary school is high; the school district wants a design that fulfills the village's expectations.

1.3 LIFE SAFETY:

1.31 Fire Protection: The owner wants to review options for automatic sprinkler systems; the well may provide enough water to make life safety feasible.

1.4 BUDGET:

1.41 $1,250,000.00 Construction Budget: Includes cost of site development and constructing all utilities needed for operation of the school.

2.0 ENVIRONMENTAL DETERMINANTS IDENTIFICATION:

2.1 Climate: Transitional climatic zone due to proximity to the Bering Sea.

2.11 Latitude, Longitude, and Elevation:

62 degrees north latitude; 162 degrees - 40' longitude; 52' above sea level elevation.

Sun Altitude: Reference ALASKA REGIONAL PROFILES.

Solar Azimuth: Reference ALASKA REGIONAL PROFILES.

Hours of Daylight: There are 7-1/2 hours of daylight/twilight on the shortest day of the year, and 24 hours of daylight/twilight on the longest day of the year.

Percent of Possible Sunshine: Unknown; believed by local residents to be approximately 25 percent.

2.12 Temperature: Characterized by mild summers and fairly cold winters. Winter storms more severe than summer storms.

Mean Temperature: Winter: -6 deg. F. average; Summer: 60 deg. F. average.

Temperature Extremes: Winter: -44 deg. F.; Summer: 80 deg. F.

Diurnal Temperature: 13 deg. to 15 deg. F. with January temperatures -2 deg. F. to +20 deg. F., and July temperatures +45 deg. F. to 60 deg. F.

Degree-Days: 14,500 heating, 4,700 freezing, and 2,800 thawing.

Number of Consecutive Days Temperature Below -20 Deg. F.: 20.

Average Latest Frost: May 28.

Average Earliest Frost: September 5.

Winter Wind Chill Temperatures: To -65 deg. F., and averaging -20 deg. F. to -30 deg. F. during winter storms.

2.13 Precipitation:

Mean Annual Precipitation: 18" of which 13" is rain or sleet falling mostly in July and August.

Mean Annual Snowfall: 50" from October to April with the earliest recorded snow in September and the latest in June.

Maximum Snowfall in 24 Hours: Unknown; residents say 20 inches.

Snowdrifting Characteristics: Local residents state there is heavy snowdrifting on leeward and windward sides of structures. For buildings on-grade, drifts over the entire structure for a six month duration are common.

Design Snow Load: 35 psf (plus design for drift and impact snow loads).

2.14 Wind: The land is low-lying with little relief from wind offered by either land features or trees. (See Drawing No. 1).

Winter Wind:

Prevailing: Speed - 8-10 mph. Direction - from the northeast. Frequency - fairly constant.

Storm: Speed - 12 to 18 mph with gusts to 50 mph. Direction - from the northeast. Frequency - 2 to 3 times annually.

Summer Wind:

Prevailing: Speed - 8-10 mph. Direction - from the southwest. Frequency - fairly constant.

Storm: Speed - 12 to 15 mph with gusts to 30 mph. Direction - from the southwest. Frequency - 3 to 4 times annually.

Katabatic Wind: None present.

Design Wind Load: 20 psf.

2.2 GEOTECHNICAL AND HYDROLOGICAL:

2.21 Geotechnical:

2.211 Topography: The village is located on the south bank of a large river in the Yukon-Kuskokwim Delta with low hills rising to the south. (See Drawing No. 1). The site is slightly sloping to the north and toward the river. (See Drawing No. 2).

2.212 Soils:

Composition: The soil conditions were evaluated from the BIA well log from the existing school and from site inspection. Silt extended to a depth of 40 feet, then graded to gravel and approached bedrock at 70 feet.

Permafrost: According to old BIA well logs, permafrost was found at the well location. However, local residents tell of sporadic occurrences of permafrost in this village which is typical of this discontinuous permafrost region.

Water Table: The water table from the old BIA well log is at 12 feet in the existing school well.

2.213 Permafrost: Per old BIA well log.

Temperature: 30 degrees F.

Depth of Permafrost: 7 feet to undetermined depth; additional soil borings are recommended.

Depth of Active Layer: 5 to 7 feet.

Vegetation: High brush and low moist tundra cover much of the area. Further upriver are birch and spruce stands which provide fuel for some of the homes in the village. The wood is hauled to the village by riverboat in the summer.

2.214 Geology:

Seismic Zone: #1 seismic activity is minor, 3.5 to 4.5 on the Richter scale; no active faults have been mapped.

Gravel Source: The nearest gravel sources are 70 miles upriver (gravel suitable for concrete aggregate) or 40 miles downstream and up the coast (sand and gravel suitable for structural backfill or drain fields).

2.22 Hydrological:

2.221 Flooding and Erosion: The village is subject to seasonal flooding due to stream overflow from ice-jamming. The five year flood level is 45 feet and the 100 year flood level is 50 feet (USGS datum). High water is +38 feet and occurs in May, and low water-ice levels can be down to +26 feet. The river is frozen over from mid-November to mid-May and break up brings high water and the threat of ice-jamming. The tributary stream and slough that run through the east end of town are subject to high water from runoff from the hills to the south, but the low marsh area tends to absorb most of these fluctuations.

The erosion potential is fairly low, the village being on a straight stretch of the river. The silty soils are highly erodable during floods. There is no landslide or avalanche potential.

2.222 Water: (See Volume II, 3.1, Site Utilities Determinants).

2.3 LOGISTICS:

2.31 Location: Subject village is located about 450 air miles from Anchorage, and 530 miles from Fairbanks.

Projected Completion Date for Construction: The school planned is to be occupied in September, 1980. This means that the educational specifications would need to be available for the architect in the fall of 1978. Design and construction documents would be prepared over the winter, and it is anticipated that the job will be bid in the spring of 1979, allowing 16 months for construction.

Other Construction Projects in Vicinity: No other construction projects other than work related to the school construction are anticipated at this time.

2.32 Air: The village has an airstrip 1/2 mile from town by gravel road. It is 2,200 feet long, surfaced with dirt and gravel, and maintained once a summer by the State. There is scheduled air service from Anchorage and Fairbanks via St. Mary's. There are also charter services in Anchorage, Fairbanks, St. Mary's, Bethel, Aniak, and Galena which have planes that can be handled at this runway. These include Caribous, capable of hauling a small cat and large lumber; Twin Otters, Beavers, and Beechcrafts. In winter, the runway can be lengthened or the lake on the north side of the river can be cleared to accommodate a Hercules (a Hercules requires a 5,000 foot runway). The lengthening requires a small caterpillar which could be brought in during the summer by barge for use in the winter. Cargo rates on scheduled service is price per pound, about 30¢ Anch-Kuchpu, with a minimum of 35 pounds. Rates on most charters are per hour, ranging from $200.00 to $800.00 depending on the type of plane. Hercules rates are by the mile, about $9.00 per mile from Anchorage.

2.33 Water: The town can be reached by water between May 25 and September 10. Freight can come from downriver on barges which meet incoming freighters from the Bering Sea. These freighters, three commercial lines and the BIA freighter, arrive once or twice a summer each and off-load either at the mouth of the river or, during high tides, at St. Mary's. From either of these two points, the cargo is barged via the one commercial barge line or by independent riverboats to Kuchpu where they are moved to shore by a forklift on planks. This limits the weight per bundle to 4,000 pounds. For trailers, the size is limited to 10 foot wide by 40 foot long and rates are slightly higher. Rates on the freighters vary with the type of material moved, from $12.00 to $33.00 per 100 pounds for construction materials from Seattle to St. Michael. The rates are fixed by weight on the barges, about $5.50 per 100 pounds delivered to the high water mark at Kuchpu from St. Michael.

Freight can also be barged downriver from Nenana, about 700 water miles, and rates from there to Kuchpu run about $7.50 per 100 pounds, and the same weight and size restrictions apply. This route can transport freight from either Fairbanks or Anchorage, arriving in Nenana by rail or truck.

In addition, gravel can be moved downriver during the summers by contract with privately-owned barges at various rates. One estimate was $35.00-$40.00 per cubic yard.

2.34 Surface: Road connections are limited to the 1/2 mile to the airport, although in winter, with the use of tracked vehicles, goods can be moved over just about any land that is frozen and free of brush.

2.35 Local Labor: For a summer building season, local labor would be hard to come by. One AVEC operator and his assistant would be available, as well as one plumber and about eight laborers (carpenter's apprentices, depending on other jobs going on. The contractor would have to supply lodging and board for his imported labor, although an arrangement to use the existing school (during the summer) for his field office could be made.

2.36 Local Equipment: Local equipment includes a small tractor-mounted backhoe left by a former contractor, a two-ton stakebed owned by the store owner, and two privately owned pick-ups. The most recent construction work done in the village was the addition to the store two years ago. A high school has also recently been built upriver about 35 miles over a period of 2-1/2 years.

2.37 Communications: Communications consist of a single (State) bush phone located at the general store. Postal service is three times a week, and telegraph service is available. There are also several private CB radios used on riverboats.

3.0 SITE UTILITIES DETERMINANTS IDENTIFICATION

3.1 WATER:

3.11 Existing System: No community water system is available. There are a few shallow private wells within the village and most people haul water from the nearby stream or one of a few private wells. The U.S. Public Health Service (PHS) is planning to explore for a water source this year with construction of a watering point due for 1979 or 1980. It is not known at this time what the method of distribution will be for PHS water.

3.12 Identification of Potential Sources: The existing elementary school has a well; however, the capacity of the well is not adequate for the new school and the quality is poor with high iron content and color. The stream that flows near the east side of the school site is of poor quality (high organic content from upstream marshes) and ceases flow in the winter. Those who use this water report that it is not fit to drink without boiling first and it is bad for washing clothes because it causes stains. This source is not feasible for a potable water source. The proposed school site is not far from the river (350 feet) that provides a thawed area in the permafrost near the river bank where a possible gallery well could be located. The route to the new school site is through a portion of the village. Rights-of-way would need to be established. This is currently being examined by the School District which foresees no problem in securing these.

3.13 Report on Water Quality Characteristics: A special report on water quality characteristics is not possible until the well source is established; however, in this instance water from this source has been previously tapped by the village store owner and is of relatively good quality during part of the year. It is affected seasonally by a high water table. Water characteristics are:

1. Color/Taste/Odor: Color is a problem with existing source. Taste is good; no odor is reported.

2. Turbidity: No specific test results are available, but there is a problem with existing source.

3. Salt Content: None present; not detectable by taste.

4. Iron Content: High - 6 mg/l.

5. Hardness: Moderate - 20 mg/l.

6. Dissolved Solids: 200 mg/l.

7. Disinfection: There is no indication of need for disinfection; no pollution problems are evident.

3.14 Water Quantity: In order to supply water needs of the new school and the existing elementary school, and to allow for future needs, it will be necessary to have a water source yielding at least 2,000 gallons per day at a peak rate of 10 gpm. The proposed source appears to be adequate; however, exact gpm and drawdown will not be known until the new gallery well is established.

3.15 Water Storage: No water storage other than a hydropneumatic tank is indicated, however, until the gallery well is established and water quantity (flow) and seasonal water quality (flood contamination and water table characteristics) are established, this item remains an assumption.

3.16 Water Treatment: Treatment appears to be necessary to keep the water system from filling with precipitated material. Filtration to remove turbidity and treatment for iron removal are indicated for the water supply system.

3.2 WASTE WATER:

3.21 Existing System: No sewer system exists in the village. PHS has studied the situation and funds for design may be available next year with construction a possibility in the mid 1980's. The existing elementary school has a septic tank and seepage pit which does not operate successfully during much of the year. Water cannot get away in the silty soil so it comes to the surface beyond the seepage pit and is a health hazard. This existing system needs to be rebuilt or replaced. In the past, there have been times when portable toilets (honey buckets) were necessary to serve the elementary school and teacherage for periods of time up to two weeks when the sewage system failed and backed up.

3.22 Quantity of Waste Water: The new school will be designed for a range of 11-20 students. With adequate water source and showers included in the school, the quantity of sewage is expected to be in the range of 500 to 600 gallons per day.

If the elementary school and living quarters are to be included in the new waste water system, the expected total quantity of sewage will range from 1,000 to 1,250 gallons per day.

3.23 Soils Condition: As stated above, soils consist of silts which are frozen much of the year. Drainage through such soil is poor. Permafrost is present in some areas but is deep enough not to be a problem for septic tank construction or to be endangered by existence of a lagoon.

3.24 Disposal Conditions: Drainage problems preclude using a system of absorption into the soil without excessive area of contact. Weather conditions are favorable to lagoon disposal by evaporation. There is an area to the east of the school site which could be used for a lagoon, but additional land will be needed. If sewage effluent were treated and chlorinated, it could be disposed of by piping it to a pond or stream. Both a stream and a marshy area are available within a reasonable distance from the school site.

3.3 SOLID WASTE:

3.31 Existing System: There is no refuse pickup in the village other than private haul to the landfill site on the river bank. The school maintenance man borrows a pickup once or twice a week to haul refuse. Burning is done at the landfill site, although this has been found to be dangerous, on occasion, when small brush fires have resulted.

The village council has promoted yearly cleanup of refuse and provided trash barrels along the roads and paths for disposal of articles that would otherwise litter the area. Volunteers haul the trash barrels to the landfill once or twice a year.

3.4 ELECTRICAL POWER:

3.41 Availability and Reliability of Utility Power: Commercial power is available from an AVEC (Alaska Village Electric Cooperative) system. The AVEC power plant has two 75 KW and one 35 KW generating units. Distribution is single phase, 7.2 KV underground cable. Service is available from a primary pedestal approximately 150 feet from the new school site. AVEC will install a transformer and service lateral to the new school without charge.

Records indicate power outages of four to five hours per month. Outages usually occur on weekends when the plant is shutdown for maintenance. Unscheduled outages due to breakdowns of about three days duration occur about once per year.

3.42 Cost of Commercial Power: The school would be charged per AVEC's "Large Commercial" rate. Essentials of this rate are:

Minimum Monthly Charge: $250/month or total of demand plus energy charge, whichever is greater.

Demand Charge: First 10 KW - No Charge.
All Over 10 KW - $10/KW.

Energy Charge: First 1500 KWHR - $.325/KWHR.
All Over 1500 KWHR - $.248/KWHR.

Demand is determined by 15 minute maximum or 95% of high demand in the previous 12 month period, whichever is greater.

3.43 Utility Power Voltage Regulation: The high voltage distribution system minimizes voltage regulation problems due to line drop. Some voltage deterioration can be expected due to inadvertent overloading of the small generating unit.

3.44 Utility Power Voltage Characteristics: Single phase, 120/240 volt only is available. No line drop voltage problems anticipated.

3.45 Cost of Electrical Generation: Cost of either utility or on-site generated power is estimated at $.26/KWHR, which translates to approximately $75.00 per million BTU. This compares with heating (at 80% efficiency) with $1.00 per gallon fuel oil, which translates to $9.25 per million BTU. Obviously, all electric heating should be discouraged.

3.46 Logistics: Small parts can be flown in by light aircraft all year-round. Parts or service are available from Anchorage within one working day, weather prmitting. Larger equipment can be barged in during summertime or flown in by large aircraft in January through March. Storage space will be very limited.

3.47 Cold Weather: Low temperature extreme is -44 degrees F.

3.48 Soils and Permafrost: Presence of permafrost and silty soils makes grounding conditions likely to be very poor.

3.5 FUEL:

3.51 Existing Facilities: Fuel oil storage facilities presently exist at the project site and serve the existing grade school. The existing fuel storage consists of six tanks of 5,000 gallon capacity each or a total capacity of 30,000 gallons. The condition of the existing tanks is good, but their present location conflicts with the location of the new school; therefore, the existing fuel storage tanks will be utilized, but relocated.

3.52 Storage Requirements: Annual fuel consumption for the existing grade school is approximately 24,000 gallons. Fuel oil is barged up the river to the site during the summer when the river is free of ice, therefore, one year's fuel storage is provided.

3.53 Soil Conditions: Soil conditions at the site consists of silt to approximate 40 foot depth and an active layer of 5 to 7 feet with permafrost below. To provide a stable foundation for the fuel storage tanks, the existing soil material at the new tank location will be removed to a depth of 7 feet and replaced with gravel. Part of the removed material will be used to construct the dike and the excess removed from the facility site.

3.54 Freezing Conditions: The extremely cold winter temperatures at the site will increase the viscosity of the fuel oil and the flow resistance of the fuel oil piping, therefore, the fuel oil distribution piping will be oversized to compensate.

3.55 Environmental Protection: The fuel oil storage tanks will be located within a diked area. The dike to be constructed of soil removed for placement of the storage tank foundation pad. The interior sides and bottom of the dike will have a suitable impervious membrane to insure fuel oil containment in case of tank spill or rupture. Installation of a valved drain is recommended to drain water from within the diked area.

3.56 Fuel Delivery: The existing fill line extending from the grade school fuel storage tanks to the unloading stations at the river will be utilized for filling the fuel oil storage tanks. This fill line will be extended from the existing storage tank location to the new fuel storage tank site and connected to all tanks.

3.57 Fuel Distribution to Buildings: Fuel distribution piping will be extended to the new facility and to the existing fuel distribution line serving the existing grade school. The distribution line to be routed as direct as possible consistent with the physical layout of the new facility. The new fuel distribution line to be installed below grade with minimum ground cover and suitably marked for location.

3.58 Fire Protection Codes: Codes to be reviewed to insure compliance with all requirements.

3.59 Power Requirements: A fuel supply pump is required to provide adequate flow during extremely cold winter temperatures. This pump to be supplied with electrical power from the new facility.

B.2 DESIGN OPTION SELECTION

The second step in METHODOLOGY following identification of determinants is the selection of applicable DESIGN OPTIONS. The design determinants identified in the initial step of the METHODOLOGY should be used as the basis for making the selection between alternative options, e.g., walls, roofs, mechanical systems.

Following the format used in Sections 4.0 through 9.0 of Volume I, options were selected for the prototype secondary school in Kuchpu, Alaska. The determinants used to select the options are referenced to aid in justifying and evaluating the decision process.

4.0 BUILDING PROGRAM OPTIONS FOR SECONDARY SCHOOLS

4.2 11-20 STUDENTS: Since a real village with associated teachers was not available for establishing an educational specification and related program and space requirements, the one used shall be the same basis used to develop the Building Program Design Options (Volume I, Section 4.2), with the selected major option being an open-plan concept as discussed under determinants identified (Section 1.13).

5.0 BUILDING SAFETY AND HEALTH REQUIREMENTS OPTIONS

5.1 VANDAL PROTECTION:

Civil Options Considered:

1. Due to flooding, severe snowdrifting, and permafrost determinants, the building must be raised above the ground with resultant floor assembly insulated. Because of this, vandal protection against fire and insulation damage to underbuilding surface must be considered.

   Options available include, from minimum to maximum protection: 1) underfloor sheathing of plywood where fire protection is not a concern or 1/2" exterior gypsum board where fire protection is a concern, or 2) chain link or other ventilative skirting. Fencing prevents access to the underside of the building, thus protecting it from vandalism and also prevents storage of materials beneath the building which is a fire hazard and can obstruct air passage needed to preserve permafrost.

   Option Selected: The option selected is galvanized chain link fence skirting because the gypsum board sheathing is vulnerable to vandalism.

2. Play Area: Options include: 1) location in areas which are conveniently observable by school staff and/or village, or both; 2) play area lighting during the dark winter season augmenting observation potential; or 3) location in traffic areas such as those at or off from entries.

   Option Selected: A combination of all of the above options is selected; the determinant of community orientation also suggests placement of entries in a position observable from the village, and lighting is already associated with the entry function.

Architectural Options Considered:

1. Window Options: 1) Placement in observable locations; 2) glazing (triple for thermal protection) including one pane of Lexan; and 3) operators that can be deactivated at the discretion of school personnel.

   Option(s) Selected: A combination of all of the above.

2. Outside Lighting Options Selected: A combination of all options listed shall be employed.

3. Doors and Locks Options Selected: A combination of all options listed shall be employed.

4. Building Controls Options Selected: A combination of all options listed shall be employed.

5. Insulation and Vapor Barrier Options Selected: All insulation and vapor barriers shall be protected with sheathing appropriate to the specific design condition.

6. Finishes Options Selected: Shall follow a method of life cycle costing.

5.2 FIRE PROTECTION:

1. Fire Alarms: Options considered include: 1) manual fire alarms, and 2) automatic fire alarms.

   Option Selected: The option selected is to design with a manual fire alarm system considering determinant 1.17, i.e., the need to keep systems easily understandable and maintainable, and determinant 1.14 which sets the facility size, i.e., 4,450 square feet, which in turn is small enough for fast evacuation in case of fire.

2. Sprinkler Systems: The owner has requested that, due to determinants 1.4 and 3.1, and budget constraints, that the option for the following wet systems be addressed as alternate bids: 1) life safety in the shop and lab areas only; 2) life safety throughout the facility; and 3) life and building safety, i.e., an I.S.O. approved system.

3. Materials: The building underside is covered with 1/2" exterior gypsum board sheathing (also required by the fact that the two-story, Scheme "B", facility must be Type V, one-hour construction, due to a second level storage room - State Fire Marshal's interpretation, 1978 - see Section 5.45, Volume I).

5.4 FREEZE-UP PROTECTION:

1. Building Design: The owner has directed that all building elements such as plumbing systems be easily accessible and maintainable from the warm interior of the facility based on determinants 1.17 and 1.222. Options include: 1) organizing wet activity areas (lab, shop, restrooms, kitchens, etc.) on a plumbing man chase; or 2) providing an accessible underfloor heated crawl space.

   Option Selected: Due to determinants 1.3 and 1.4, the complexity and cost of heated underfloor crawl space in the second option above will not be pursued. It is felt that the first option above with specific design variations is the most desirable option to pursue.

2. Building Operation: Additional freeze-up protection options are presented under this section considering identified determinants 1.17, 1.4, and 3.4.

   Option Selected: Include standby generation sufficient to save the building, in addition to designing a simple direct system for draining freeze susceptible piping.

5.4 CODE IMPACT: By law, no options to codes exist; however, common sense dictates that in rural bush schools, they should be considered as previously discussed in Volume I, Section 5.0.

6.0 SITE UTILITIES OPTIONS

6.1 WATER:

6.11 Source Options:

1. Surface Water: The river is a difficult source of water because its level changes with the seasons, it is covered by ice nearly half of the year, it has high turbidity in the summer, it is subject to contamination from up-river communities and treatment would have to be extensive.

The stream is likewise a poor source of water because it has high color and chemical content and freezes in the winter. There are no nearby ponds or lakes suitable for a water source. Rainwater is not abundant at this site and the snow has a low moisture content. (See Volume I, Section 2.1, Climate).

Option Selected: None.

2. Groundwater: Wells at the school and in the village have not been very successful producers of good water. There are indications that there is a better possibility of dependable water source located in the bank of the river where the shore area is kept thawed and the water table is affected by the presence of the river.

   Option Selected: Develop a conventional well or gallery well near the river bank.

6.12 Pump Options: Distance from the school and difference in elevation dictate that a pump must be at the source. Environmental conditions make a submersible pump the best choice for protection from freezing.

Option Selected: Submersible pump.

6.13 Freeze Protection Options: Piping from the well to the school building could be "Arctic" pipe laid on the ground or supported above it. This type of pipe is easier to maintain than underground pipe and leaks show themselves more readily, but it is also more subject to damage by freezing, vandalism or other causes. Underground piping is a possibility at this location, but much care must be taken to avoid damage by frost action in the silty soil. To avoid freezing when water flow is low or stopped, a heat tape installation will be needed.

Option Selected: Buried insulated pipe with heat tape.

6.14 Water Treatment Options: There are packaged treatment plants available that could successfully treat water of the quality found at this village. They are for the most part too large to be housed in the space available in the school and would be too costly to install. Smaller ion exchange units, using salt for recharge, would not be adequate to reduce the iron content to acceptable levels. Some form of oxidation needs to precede ion exchange treatment or oxidation may be used as the primary treatment. Settling and filtration will be necessary to complete the treatment. Chemical supplies needed for treatment would be reduced if oxidation were the only chemical treatment required.

Option Selected: Super chlorination followed by aeration, settling, and filtration. System would consist of piping and tanks fabricated in Alaska.

6.2 WASTE WATER:

6.21 Disposal Options: A septic tank with a soil absorption mound is a possible alternative. Suitable gravel and sand would have to be brought to the site to construct such a mound. This is a costly alternative because the gravel source is so far from the village.

The quantity of sewage could be handled by a small treatment plant within the building, but space is a problem because water treatment is also necessary. Even with a treatment plant in the building, there must be a method of getting rid of the effluent with an absorption field or lagoon. A small lagoon with natural aeration is another possible solution that could work, if the land needed is available.

Option Selected: A facultative lagoon to be constructed on land next to the new school.

6.22 Piping and Pumping Options: The most advantageous location for a lagoon appears to be the area southeast from the new school. To avoid the odor problems and to keep necessary clearance from the stream, the lagoon will have to be located slightly uphill from the school and will need to be raised above the ground level to avoid degrading any underlying permafrost; therefore, pumping will be required to bring the sewage to the lagoon. Another possibility is to cross the creek and use the area beyond for a lagoon, but the distance for piping is much greater and flooding is also a problem. Piping could be underground or exposed on supports above the ground, but in any case it must be protected from breakage and freezing to avoid pollution problems. The overhead location is preferable where the pipe empties into the lagoon to avoid breakage from ice action.

Option Selected: Install sump and pump in school and pump through an insulated heat traced and raised pipe to a lagoon located near the school.

6.23 Waste Water Treatment Options: A facultative lagoon of sufficient size can serve as both a treatment and a disposal facility if precipitation is relatively light, and there is enough evaporation to keep the liquid level from exceeding the lagoon capacity. Care should be taken to avoid snowdrifting into the lagoon which would increase the water level. Although aerated lagoons are more efficient in treatment sewage, the additional cost of providing air compressors and air diffusing equipment, together with the necessary maintenance and operation, makes them less desirable in "bush" communities than facultative type lagoons. Some of the difference in cost could be spent on additional volume for the lagoon to help insure having maintenance-free operation.

Option Selected: The type of treatment for this site was established by the Disposal Option, Section 6.21, above.

6.3 SOLID WASTE:

1. No new system is contemplated. The school district should address this area to the village council for future planning and solution. Container storage is provided in the new school at a point convenient to load out into a truck. Protection from wind and animals is also provided.

2. No burning will be done at the school site.

6.4 ELECTRICAL POWER: AVEC power is conveniently available on-site. The comparison between alternative power supplies is covered in Section 9.4, Volume II.

6.5 FUEL:

1. A new fuel storage site has been selected, and a new dike required.

2. Fuel consumption for the new school is estimated at 25,000 gallons annually. The combined annual fuel consumption for new and existing school is estimated at 49,000 gallons. With a 15% delivery contingency added to annual consumption, the storage requirement would be 56,350 gallons.

3. Two new 15,000 gallon fuel storage tanks will be provided with the six existing 5,000 gallon storage tanks.

7.0 SITING OF BUILDING OPTIONS

7.1 MASTERPLANNING FOR GROWTH: The owner, considering options for masterplanning for growth as presented in Volume I, has stated a preference for the Composite Structures approach with modifications (see Section 7.113). The school district does not have the ability to coordinate and plan for other public agencies to be included into a community educational and service center.

Village growth is relatively static; however, school attendance is expected to increase as more families and children identify with the need for education, and as the new facility will provide more convenient education (before, secondary students were shipped out to regional boarding schools).

Although the district's choice has been to go with the open plan concept, there is village concern that, despite the A/E's best efforts, having classrooms in the multipurpose room may not work; and that even without classrooms, the multipurpose room is too small because the elementary school and village will be sharing it. Therefore, the village and school district want the masterplan to include design for expansion of the multipurpose room to full size, addition of a separate classroom and separate resource area and expansion of the shop.

Regarding dispersed and campus plan approaches, the school district and village feel that ultimate facility is too small to consider these options, and additionally that these options make administration difficult as only 1-1/2 staff personnel are planned. However, they feel for fire safety and acoustics that the shop could be campused out in the master-plan.

7.2 ORIENTATION TO ENVIRONMENTAL FACTORS: Applying applicable identified determinants from Volume II, METHODOLOGY, to options as presented in Volume I, DESIGN OPTIONS, the following option selections have been made for inclusion in the schematic design solution.

7.212 Wind and Snowdrifting: The narrowest portion of the building shall, to the greatest extent possible, be oriented into the prevailing winter wind to limit snowdrifting. Entries shall be designed to have doors protected from the wind and preferably be located on the wind-swept side of the facility to avoid snowdrifting the entries closed.

7.216 Sun: Window placement priorities based on Determinant 2.1 should have southeast and west exposures. Protection from glare should be considered, especially on the south exposure.

7.22 Flood Plain: From determinants identified in Volume II, Section 2.221, we can expect flooding on the school site on a 100-year cycle. Flooding is minor and will only affect the northeast corner of the school site on a 100-year cycle. On the five-year cycle, flooding can be observed coming up to the site, but not over it. For this example, the owner has directed us to design on a 30-year flood cycle basis.

Options:

Options for designing for the 100-year flood include: 1) locating the facility in the higher southwest corner of the site; or 2) should other determinants dictate a northeast site positioning of the facility, a gravel pad can be constructed to raise the building ground base above the flood level or constructing wood decks to be above this flood level; or 3) as flood water depth is only two to three feet every 100 years, flooding may be addressed by raising the building floor assembly elevation above flood level as is required already for permafrost protection.

Option Selected: Final option selection is dependent on other determinants, i.e., masterplanning for expansion, community orientation and site utilities and appurtenances. However, the optimum option from a flood point of view is the first option above.

7.3 ORIENTATION TO COMMUNITY:

Options: The village fans out down to the river on the north and west property boundaries. The elementary school occupies the prime corner of the site, i.e., the northwest corner. From determinants 1.13 and 2.3, two options are apparent: orientation of building (entries) to the north or to the west roads exist on both these sides and the majority of the community lies to the northwest.

Option Selected: As the north is subject to flooding as previously discussed, and as the proximity to sunlight is not good, and as drifting is likely to be heavy on the north side, the west side is the option selected.

7.4 SITE MODIFICATIONS: Anticipated site modifications include extension of the gravel surcharge road on the west approaching the building as sited. As piling will be placed while the active layer is still frozen, and as play areas are anticipated to be established on gravel surcharge pads the same as local road construction, no other site modifications are anticipated.

8.0 BUILDING ENVELOPE AND STRUCTURE OPTIONS

8.1 SOILS TESTS: The only soils information presently available is from a very old BIA well log.

Options: Options include: 1) basing design on the one well log; and 2) sending a soils team out to make additional tests.

Option Selected: The school district has decided to select the second option above, and send out a soils team to make additional tests. The school district will contract directly with a consultant to provide needed investigative data for the designer. BIA logs, while giving an indication of soil expeditions for the site, do not define potential soil anomolies, ice lensing, or permafrost which may be unique to this site.

8.2 FOUNDATION SYSTEMS: The project soils engineer has examined the old BIA well log and aerial photographs. He suspects that permafrost may be sporadic throughout the site which is common in this region of discontinuous permafrost.

Options: He has identified two foundation system options: 1) continuous poured concrete footings on treated soils, and 2) piling. The pending soils test may change this selection; however, at this time, the following reasons substantiate the selection of piling:

1. Excavation of the active layer and importation of gravel backfill for installation of continuous footings is too costly.

2. Heat loss from the continuous footing will thaw potential permafrost or ice lenses and result in heaving of the foundation.

3. The piling will most effectively isolate the building's waste heat from potential permafrost and ice lenses.

4. The snowdrifting problem encountered in the village is enhanced by raising the building on piling, thus allowing the wind to scour snow from the leeside of the building.

Option Selected: Based on identified determinants 2.2, 2.3, and 1.4, it is assessed that excavation of the active layer for installation of continuous footings, as well as the remoteness of gravel source for fill, will be too costly; therefore, Option 2, driven piles, has been selected.

8.42 Floor Systems: The owner has complained of cold floors, an age-old arctic problem. He has requested that the A/E again attempt to find a solution which will solve this problem and meet code requirements. As an example of this type of request, we illustrate below a solution for our fictitious owner. It is common for an architect to work with the Fire Marshal as described below.

Options presented as Floor System 1, 2 and 3 in the State RURAL SCHOOLS PROTOTYPE ANALYSIS have been found unacceptable by the State Fire Marshal for use as a plenum. A plenum must be made of noncombustible materials. The Fire Marshal was asked if noncombustible wood would make a difference; the answer was negative, as noncombustible wood is salt-treated, and passing air over it removes the salts in time, causing it to lose its fire rating. The only remaining option in the State study is observed in Floor System No. 1, Figure 8.10, i.e., deep framing with considerable insulation in an attempt to raise the inside floor temperature (considered the most common and effective solution now in use).

However, with research and development, the A/E has come about a solution for a panelized floor system which contains both structure and a noncombustible air plenum. The system has been reviewed with the State Fire Marshal who appeared enthusiastic and agreed to send drawings of the system to I.C.B.O. for approval. Should I.C.B.O. approve the assembly, it shall be the option utilized, with the entire floor system being pressurized heated and ventilated supply air plenum. If not, the option in VOLUME I, OPTIONS, i.e., Floor System #1, Figure 8.10, shall be used and the mechanical engineer will provide perimeter heating ducts along walls at floor level.

8.43 Walls: Considerations for design of wall systems were discussed under DESIGN OPTIONS, Volume I. Two basic options were presented (reference Figures 8.15 and 8.16). Neither option will be used in its entirety. The project mechanical engineer, in reviewing Section 1.0, BUILDING PROGRAM DETERMINANTS, has observed that the volume of cabinetry to be placed along walls is considerable. He has advised that the cabinetry and its contents placed against an exterior wall such as the one in Figure 8.14 will cause frost build up on the interior surface of the wall.

The option selected is the wall assembly option closely resembling Figure 8.10, with the exception that: 1) air is passed from the floor plenum (if approved) or slim line perimeter ducts in the furred-out chase space; 2) that the vapor barrier must be covered with 5/8", Type "X", gypsum board; 3) that furring must be metal and positioned vertically to allow air movement; and 4) the two-story, Scheme "B", requires one-hour construction, a 1/2" layer of exterior gypsum board must be applied over the plywood sheathing on the exterior of all walls.

In addition to the heating problem, determinant 2.1, Climate, forms the basis for wall framing, i.e., 2 x 6's at 16" on center are required to carry live (snow) and dead load from the roof above, 2 x 8's are required for wind load in the multipurpose room, and the mechanical engineer wants an insulating R value of 24 in the wall. Therefore, the decision is to use 2 x 8 framing at 16" on center with two layers of batt insulation, 3-1/2" R-11, and 3-5/8" R-13. Although this framing depth is not needed for wind loading on exterior walls other than the multipurpose room, it shall be continued around the entire exterior for the insulating depth it provides.

8.44 Roofs: The cold ventilated roof form is the option selected from VOLUME I, DESIGN OPTIONS, AS depicted in Figure 8.19.

Optional assemblies include: 1) metal roofing: 2 x 2 treated wood blocking; structural stress skin panel with venting paint on the top (cold side), skin supported on primary structural members as required; second vapor barrier (as rigid insulation used in the stress skin panel is a vapor barrier) applied to underside of stress skin panel; for the two-story, Scheme "B", only use 5/8", Type "X", gypsum board attached to underside of stress skin panel and wrapped around primary structural members; acoustical treatment as required applied to gypsum board; surface mounted conduit and suspended light fixtures. 2) Metal roof: 15 pound felt; plywood sheathing; structural framing containing vent space above and insulation below; vapor barrier; 2 x 2 furring at 16 inches on center to allow space for conduit; for the two-story, Scheme "B", only use 5/8", Type "X", gypsum board; acoustical treatment as required.

Of the two optional assemblies, the second is the most commonly used; however, school personnel claim that, despite venting, hoarfrost forms on the underside of the plywood sheathing. This, in time, melts and runs back down through insulation and vapor barrier onto gypsum board ceilings and causes long-term damage. Additionally, similar damage is caused by snow blowing into the roof vents.

The first assembly is an attempt to solve this problem by combining cold and hot roof technologies along with the efficiency of stress skinned panels. The stressed skin panel is a material efficient structural member meaning less cost from material and freight weight standpoints. The vent painted cold surface side, combined with the 2 x 2 furring, allows the panel which is normally used in hot roof assemblies to behave like a cold roof assembly. However, in its design, condensation resulting from vapor leaks, wind carried snow into eave vents and hoarfrost is now trapped by the painted cold skin and allowed to drain out the eave vents. It is important to note that this second option has not, to our knowledge, been applied.

Option Selected: Is dependent on structural considerations, i.e., fit with building design, budget determinants, and should the previously stated considerations and determinants indicate Option 1, State and school personnel willingness to test the theory.

8.61 Windows: The window option selected is the option presented in VOLUME I, DESIGN OPTIONS. Specific window design considerations addressed under Design Options in the study shall be utilized in the finished design.

8.8 ENTRIES: The entries option selected from VOLUME I, DESIGN OPTIONS, is depicted in Figure 8.46, the single heated vestibule. This selection was based on two climatic determinants: mean winter temperature at -6 degrees F., and winter prevailing wind direction from the northeast at 8 to 10 mph. It is felt that mean winter temperatures are not significantly different from these in Anchorage, where the single heated vestibule concept works quite well, and that orientation of the entry perpendicular to the prevailing wind will adequately safeguard against wind blowing into the entry, as well as provides obstruction from snowdrifting.

The site lends itself to these ends as well as affording ample opportunities for orientation towards the community, i.e., student circulation routes and supply avenues, i.e., airport and river.

9.0 BUILDING UTILITIES OPTIONS

9.1 HEATING SYSTEM:

9.11 Total Building Heating Load (for Scheme "A" Only):

Building heat loss is 132,000 BTU/Hr.
Building ventilation heating load is 91,800 BTU/Hr.
Domestic hot water load is 50,000 BTU/Hr.

9.12 Heating Source: Heating source will be diesel oil. Coal is not available and wood must be hauled 50 miles and therefore not considered as a fuel. "Waste heat" was not considered feasible in preliminary calculations as discussed in Section 9.42, On-Site Generation.

9.13 System Medium: Heat generation shall be oil-fired hot air furnaces for a combined heating and ventilating air system. Two furnaces will be provided, one zone for multipurpose and one zone for remainder of building. Temperature controls will be line voltage electric or low voltage electric with furnaces prewired and factory tested.

9.2 VENTILATION/COOLING SYSTEM:

9.21 Ventilation Requirements: The total minimum outside air for ventilation is 850 cfm. The total circulated air for ventilation is 4250 cfm.

Toilet Exhaust Air (Boys)	200 cfm
Toilet Exhaust Air (Girls)	180 cfm
Maintenance Room	50 cfm
Water Treatment Room	100 cfm
Total Fixed Exhaust	530 cfm
Special Exhausts: (Separately switched)	
Science Fume Hood (Makeup Air Type)	400 cfm
Home Science Range Hood	200 cfm
Welding Booth	200 cfm
Finishing Room	200 cfm

The combined heating and ventilation system design will allow a fixed minimum exhaust of 530 cfm of the total 850 cfm of outside air brought in at -40 degrees F. Therefore, at winter mean temperature of -6 degrees F. per design determinant 2.12, outside air will increase to 1950 cfm which allows all building exhaust systems at 1530 cfm to operate without building being negative to outside. The remaining 420 cfm will provide positive building pressure.

The fixed exhaust air system will have a common exhaust fan. The special exhausts will have individual fans with manual switch.

9.3 PLUMBING:

9.31 Water Supply: A small hydropneumatic pressure system will be designed with the submersible well pump and water treatment equipment discussed under Section 6.0. Sweat copper fittings and tubing is recommended within the building.

9.32 Waste System: A conventional gravity waste and vent system with corrosion-resistant piping for the Science Room. All waste piping will flow by gravity to a receiving tank and pump as described under Section 6.0 for waste disposal. At this schematic design level, the operating costs of the water system will not offset more water conserving waste systems. However, this needs a more in-depth review in design development level.

9.33 Fixtures: With only two water closets, we are recommending the "Microphor" stainless steel water closet which uses 1-1/2 to 2 quarts of water per flush. This will require a residential type single stage air compressor with 1/2 Hp., 120 volt, single phase motor completely factory assembled and tested with gauges, controls, tank, compressor. Other fixtures, urinal, lavatory, showers will be stainless steel with low water flow restrictors on the plumbing supplies.

9.4 ELECTRICAL POWER:

9.41 General: Electrical power is expensive and must be used sparingly to reduce operating costs. A strong recommendation will be made to eliminate all electric cooking and other heating appliances which can be operated with fuel oil instead.

Simple, manual controls will be used wherever possible. No voltage regulators or under-voltage relays will be used, but a recommendation will be made that all electric motors will be oversized to operate during under-voltage conditions without damage.

9.42 On-Site Generation: Cost analysis of various types of on-site generation and purchased power yields the following comparison:

Case 1: Minimum Standby.

Annual cost of purchased power (AVEC)	$17,180
Annualized cost of minimum standby generator (7.5 KW)	525
Total Annual Cost	$17,705

Case 2: Full Standby.

Annual cost of purchased power (AVEC)	$17,180
Annualized cost of standby generator (30 KW)	1,750
Total Annual Cost	$18,930

Case 3: 100% On-Site Generation with waste heat recovery, annualized first cost plus annual operating costs $22,250
Less cost of fuel replaced by W.H. recovery (2,400)

Total Annual Cost $19,850

Owner opted for Case 1, with an advantage of $2,100 per year over Case 3, and approximately $1,200 per year advantage over Case 2.

9.43 Building Service and Power Distribution:

9.431 Materials and Equipment: Top quality materials and equipment will be specified. No aluminum conductors will be allowed. Circuit breaker panelboards will be specified with bolt on breakers.

9.432 Metering: AVEC will provide KWHR and KW demand metering.

9.433 Vapor Barrier Penetrations: Vapor barrier penetrations will be prohibited except where absolutely necessary. Where penetrations are required, vapor barrier will be carefully repaired around penetration and conduit seals will be installed.

9.434 Classrooms: Multioutlet assemblies, surface mounted, with 20 amp, 120 volt receptacles 60" on center will be provided in all classrooms.

9.435 Shop: Multioutlet assemblies with 20 amp, 120 volt outlets spaced 24" apart will be provided above shop benches. Additionally, Plugmold G-4000 will be provided around the room perimeter and across the center of the ceiling for future equipment. A surface mounted circuit breaker panelboard with a shunt-trip main breaker and "panic" button will be provided in the shop.

9.436 Multipurpose Areas: Surface mounted, 20 amp, 120 volt receptacles will be provided at 10 foot intervals on the perimeter of the multipurpose area.

9.437 Other Areas: Sufficient number of receptacles will be provided in other areas for maintenance, etc.

9.44 Lighting:

9.441 Lamps: All interior lighting will use 40 watt, cool-white 48" fluorescent lamps with the exception of small closets and similar areas. Some low-bay mercury vapor fixtures will be used to supplement lighting levels in the academic portion of the multipurpose area. High-pressure sodium lamps will be used in exterior fixtures.

9.442 Interior Finishes: It is recommended that surface finishes have reflectance values of no less than 80, 50 and 20 percent for ceilings, walls and floors respectively.

9.443 Fixtures: Fixtures for general lighting are chosen as follows:

Classrooms, Offices, Resource Area: Commercial 2' x 4', two or four tube fluorescent, flat diffuser with hinged frame, surface or pendant mount. Lighting over the academic areas of the multipurpose room will be supplemented with mercury vapor fixtures.

Shops, Multipurpose: Industrial four tube fluorescent fixtures with wire guard, metal reflector, surface or pendant mount.

Restrooms, Showers: Two tube fluorescent, damp location label, polycarbonate diffuser.

Entryway: 150 W High Pressure Sodium with polycarbonate diffuser.

9.444 Switching: Line voltage switching to be provided for all lighting. Bi-level switching to be provided for classrooms and multipurpose area.

9.445 Diffusers: All 2' x 4' commercial fluorescent fixtures will have flat, full .125" thick acrylic diffusers in hinged metal frames. Fixtures in restrooms and outdoors will have gasketed, polycarbonate diffusers.

9.446 Exit and Emergency Lighting: Exit signs will be self-powered type. Emergency lights will be self-contained with polycarbonate diffusers, tungsten-halogen lamps, and long-life sealed lead-acid batteries.

9.45 Communications:

9.451 General: The owner has chosen the following communications systems:

Public Address System in Multipurpose Room
Fire Alarm System
Raceway for Future Telephone
Raceway for Future MATV System
Clocks

9.452 Public Address System: A good quality P.A. system will be provided for the multipurpose room. Radiating horns will be located in the center of the room. The P.A. system amplifier will accept microphone, record player, and tape player inputs. Microphone jacks will be provided at several locations in the multipurpose room.

9.452 Fire Alarm System: A simple, single zone fire alarm system has been chosen. Non-breakglass pull stations will be provided at all exits. Smoke detectors will be located in the corridors and classrooms. Heat detectors will be provided in the multipurpose room, restrooms, and mechanical room. Interior alarm horns will include flashing red lights. An outside rotating beacon mounted above the roof will be included. System will be Class A and will include a long-life sealed lead-acid standby battery.

9.453 Telephone: Raceway will be installed for future telephone service, including stubout to exterior of building.

9.454 TV System: Raceway will be provided for future MATV system including outlets in each classroom and multipurpose room. A stubout will be provided through roof.

9.455 Clocks: Battery powered wall clocks will be provided by the Owner.

9.46 Grounding System: System grounding will be provided by a bare copper conductor buried 24" at the perimeter of the school with driven ground rods, 20 feet on center. System ground will also be bonded to cold water piping.

SCHEMATIC DESIGN

B.3 SCHEMATIC DESIGN

a. BASIS OF DESIGN:

1) ARCHITECTURAL:

a) General: The structure is a wood frame building of one story providing an educational program area for 11-20 secondary students. The new school is being designed with multipurpose, industrial education, science, storage, and toilet facilities. The multipurpose room will also be used by elementary students and the community. State DOE space guidelines for secondary schools were used.

b) Building Location: The most suitable building location has been determined to be the southwest corner of the site.

Considerations:

(1) Free from flooding.

(2) Good orientation to the community and existing elementary school.

(3) Good solar orientation from south and west.

(4) Good access for people and goods from the road linking airport, river, and community.

(5) Natural site drainage.

(6) Resultant snowdrifting away from new and existing schools and associated entry access nodes.

(7) Development of a gravel surcharge play area as an extension of the gravel surcharge road on the west with the added advantage of this pad providing a work area for the contractor during construction.

(8) Existing fuel storage for the elementary school is too close to both facilities, not presently diked, inadequate to serve the new facility as well as the existing elementary school, and obstructing a potential future warm link between the new secondary school and existing elementary school providing for shared use of the multipurpose space at some future date. The tank farm will, therefore, have to be relocated and expanded.

The proposed new fuel storage location is in the southeast corner of the site on high, well-drained ground where a gravity feed system to both the new secondary school and the existing elementary school is possible. The existing fill line approaching from the AVEC site will have to be rerouted slightly. Diking of the tanks will be provided by by a lined gravel or silt berm (silt expected to be available from excavation for waste water disposal in this area); snowdrifting resulting from tanks in this location is not expected to affect other site uses.

(9) The proposed facility location obstructs the back east portion of the site for play area; however, it may be used for building expansion, and the new facility will be located as far east as possible to allow for surcharge gravel-surfaced play areas to the west entry side of the facility to be shared by the elementary school.

c) Masterplan: The masterplan expansion of the facility includes a warm linkage with the existing elementary school, expansion of the multipurpose room to full size, addition of a separate classroom to the east, addition of a separate resource area to the east, and optional attached expansion of the shop or "campus" expansion of the shop.

d) Basic Schematic Floor Plan:

(1) General: The open plan concept developed in these schematics is as chosen by the owner, and as discussed in the State RURAL SCHOOLS PROTOTYPE ANALYSIS. The single story, Scheme "A" is planned for pull-down stair-accessible storage on a second level over the corridor. By code, it is designed to meet Type V-N construction as defined in Table 5-D of the 1976 UBC. The two-story, Scheme "B", is planned for a full "approved exit" type stair on a second level over the wet core areas and lab. Scheme "B" must be designed to meet Type V, one-hour construction as defined in Table 5-D of the 1976 U.B.C.

As student enrollment is projected at 17 students, the building will be classified as an E-2 occupancy by the 1976 U.B.C., i.e., for 50 or fewer students through the 12th grade.

The general construction will be a wood pile foundation system with glue-laminated beams spanning between piles. The floor system (whether the warm air plenum option or the heavily insulated option with perimeter ducts) shall be of panelized structural stress skin construction.

Exterior wall systems shall be conventional framing with an option for the contractor to use structural insulated stress skin panels similar to those on the roof. Roof framing shall be structural insulated stress skin panels as previously described under roof assembly options.

(a) Exterior Finishes: Exterior wall finishes shall be prefinished metal siding. Roof systems shall be prefinished metal roofing.

(b) Interior Wall Finishes:

Multipurpose Room: Walls shall have a carpet wainscot to door head height as one part of acoustical treatment for multiple use of this space. Surfaces above shall be painted and have strategically placed and mechanically fastened acoustical panels over the painted surface.

Shop: Shall have 1/4 inch thick cement asbestos board wainscot to door head height on inside of exterior walls, and 1/2 inch noncombustible plywood wainscot to door head height on interior walls.

Restroom/Locker Room/Shower Areas: Shall have ceramic tile walls specified in accordance with Tile Council of America, Inc. Standards.

Lab: Shall be painted with epoxy paint.

Pipe Chase and Water Treatment Areas: Walls shall be painted with epoxy paint.

Corridor: Shall have a vinyl wall covering wainscot to door head height and a railing mounted at 36 inches off the floor. Wall areas above the wainscot will have latex enamel paint.

Mechanical Space: Walls shall have epoxy paint.

Vestibule: Shall have vinyl wall covering.

Storage Room: Shall have latex enamel.

Office: Shall have vinyl wall covering.

Maintenance Room: Shall have ceramic tiles at the service sink, and epoxy paint elsewhere with pegboard between bench and vapor cabinets for hand tool storage.

Stairs: Shall have vinyl wall covering.

(c) Floor Finishes:

Multipurpose Room: Shall have gym floor carpeting which will afford the second component of multipurpose room acoustical design.

Shop: Shall be thin-set quarry tile over plywood underlayment with a 6" high quarry tile base.

Restroom/Locker Room/Shower Areas: Shall have grout-set ceramic tile floors draining to floor drains at the pipe chase wall. The difference in floor elevation due to the grout setting bed shall be taken up in the corridor leading to these rooms by ramping.

Lab: Floors shall be vinyl asbestos tile.

Pipe Chase and Water Treatment Areas: Shall have two floors, removable metal gratings at the primary floor level, and an epoxy-painted sheet metal lined wall and floor finish surface in the dropped pipe chase space below the grating.

Corridor: Shall be nylon carpet with anti-static yarn.

Mechanical Space: Shall be epoxy paint over sheet metal over plywood underlayment. The sheet metal shall be turned up all walls and floor penetrations a minimum of 6 inches and shall have all joints soldered to form a water/oil-tight pan.

Vestibule: Shall have corded tile.

Storage Room: Shall have vinyl asbestos tile.

Office: Shall be carpeted.

Maintenance Room: Shall be thin-set quarry or ceramic tile.

Stair Treads, Risers and Stringers: Shall be rubber with landings being vinyl asbestos tile.

(d) Ceiling Finishes:

Multipurpose Room: Ceilings shall generally be latex enamel paint with acoustical insulation batts fastened to a protective wire mesh that is suspended between the ceiling beams.

Shop: Shall be treated the same as the multipurpose room ceiling.

Restroom/Locker Room/Shower Area: Shall be epoxy painted, water-resistant gypsum wallboard.

Lab: Shall receive acoustical ceiling tiles.

Pipe Chase and Water Treatment Areas: Shall be epoxy paint on 5/8", Type "X", gypsum board.

Corridor: Shall be acoustical ceiling tile.

Mechanical Space: Ceiling shall be epoxy paint on 5/8", Type "X", gypsum board.

Vestibule: Shall be acoustical ceiling tile.

Storage Room: Shall be latex enamel paint on 5/8", Type "X", gypsum board.

Office: Shall be acoustical ceiling tile.

Maintenance Room: Shall be acoustical ceiling tile.

Stairs: Shall be latex enamel over 5/8", Type "X", gypsum board.

(2) Building Entrance/Vestibule: The building entrances have been established at either end of a double loaded corridor for ease of facility expansion. The entries are oriented perpendicular to the wind to avoid snowdrifting in front of them. The first set of vestibule doors has been mounted flush with the exterior wall to maintain good snow scour characteristics. The second set of vestibule doors has been set back sufficiently to allow the first set of doors to close before a person entering opens the inner set of doors.

The ramp has been included at the main entry for handicap access as well as shop and supply access. It utilizes the gravel surcharge drive and play area as a point of origin which reduces its required rise/run and subsequent cost.

(3) Multipurpose Room: The multipurpose room has been designed around a half-court gym, with academic and resource areas divided frp, this space by use of a manually operated portable wall. The portable wall is made up of individual four foot panels. Panel surfaces on the physical education side are carpet for acoustical purposes. On the academic and resource side, some panels have chalk and tackboard surfaces. The wall's acoustical rating is 48 S.T.C., which should be sufficient to screen noise from the gym side except for impact noises such as balls bouncing off the wall. To alleviate this problem, a drop net from the ceiling will be provided 12 inches out from the wall on the gym side. One additional planned use of the multipurpose room is for storage of the contract-provided portable scaffolding needed for replacement of multipurpose room light fixtures.

When it is desired to use the entire space for an activity such as a basketball game, the drop net is manually pulled up to the ceiling, completely out of the way and requiring no special storage space. The portable wall is then moved on its overhead track a panel at a time and stored along each wall. Next the free standing acoustical partition screens between the resource and academic area are carried to the sidelines, tables are folded, and, having wheeled bases, are rolled to the sidelines. Chairs are also moved to the sidelines, where they can be used for spectator seating in addition to bleachers provided. As portable cabinetry has already been positioned along the walls, no moving of these heavy items is required. The whole conversion of the space is anticipated to take no longer than 20 minutes depending on the number of persons helping in the conversion.

(4) Lab Room: The lab room is located opposite the academic and resource areas and as far away from the shop area as possible. In addition to programmed activities, it is intended that this space be a quiet refuge, and therefore its two interior walls will be sound insulated.

(5) Shop: The shop has been located at the front entry for ease of material deliveries and shared use of the ramp. Double doors are provided directly to the exterior and the related ramp to facilitate movement of materials in and out.

(6) Restrooms/Locker Rooms/Shower Areas: These rooms have been centrally located for ease of access and as an acoustical separation between shop and lab. They are designed to back up to a plumbing manchase and water treatment area proving for total accessibility to all plumbing piping.

(7) Maintenance Room: The maintenance room is provided on the ground floor with easy access to the shop. It has room for storage of wet and dry vacuums and mop pails under the bench, a service sink with mop holders above, and shelving/cabinetry above the bench for maintenance manuals, small spare parts, and hand tools. The close proximity to the school shop allows for the maintenance person to use school shop power tools.

(8) Office: The school office is centrally located and provides for one work station with typewriter and active student files. Inactive files must be stored in the storage room on the second level.

(9) Corridor: The corridor is designed to be seven feet wide to allow for double doors at the entries, one inswinging and one outswinging. Of this width, only 44 inches is required for corridor width, with the remainder of the space being divided into alcoves for student compartments.

(10) Stairs: In the two-story, Scheme "B", a stair has been added for ease of access to storage and mechanical areas on the second level.

(11) Pipe Chase and Water Treatment: The pipe chase and water treatment areas have been combined, as they are both connected with water supply. Storage for treatment materials is provided in the treatment room. This scaffolding is quite long and space-consuming, and the pipe chase is ideal for its storage.

(12) Storage Room: The upper level storage room is provided with both adjustable and fixed shelving of varying depths.

(13) Mechanical Room: The mechanical room contains modular oil-fired down-flow furnaces joined by a common supply air manifold for heat and ventilation. All modular furnaces are component identical for ease in storing replacement parts and ease of maintenance knowledge required. The multiple furnaces are intended as an additional safeguard against building freeze-up due to furnace failure. In addition to the furnaces, a small 7.5 KW diesel, save-the-building generator, is provided as a packaged assembly with the location to be determined.

2) CIVIL:

a) General Soil Conditions: The soils suggested by the well log and initial site inspection indicated silty material with discontinuous permafrost. Six exploratory holes were drilled to the depth of 35 feet to determine the extent of frozen material and possible ice lensing (to locate the building on thawed soils if possible), and to determine the bearing capacity of the soil, depth of organic material, and level of the water table.

The subsurface exploration could have been performed last summer by barging the drilling equipment down from Nenana; however, this would have tied the rig up four to six weeks in transit, with no guarantee of getting it out prior to freeze-up. The alternative, to fly in the drilling equipment in December after freeze-up, fit into the building schedule, allowed minimum mobilation and demobilization time, and was effected expeditiously by the use of a Caribou STOL aircraft. The timing was such that recommendations could be made in time for foundation and flooring materials to be flown in by late April with a Hercules for construction to start in late May.

The subsurface investigation supported the finding as depicted on the BIA well log. The soil is a nonplastic silt frozen to a depth of three feet, damp above 15 feet, and saturated below. A frozen ice lens two feet thick was encountered in one test hole at a depth of 10 feet.

b) Foundation: Pilings are recommended due to the lack of nonfrost susceptible fill, and the potential of differential settlement with shallow spread footings due to thawing of ice lenses under the building site.

End bearing pilings will be used due to the difficulty of defining a friction factor between the soil and piling in the presence of sporadic permafrost. Steel piling are selected because of the ease of increasing the pile length if greater depth is required, and the problems of driving wood piles through frozen ground. Predrilled holes with pile insertion was discarded due to the additional equipment required to test load and/or drive. Steel pipe pilings driven to a depth of 30 feet (minimum) are expected to have a bearing capacity of 20 tons each. Actual bearing capacity should be determined using a dynamic pile driving formula.

No seasonal frost break in the upper five feet of the soil-steel pipe interface will be required due to the relatively smooth pile surface and depth of embedment. However, connections between pile and superstructure must be installed to allow releveling during and subsequent to construction. A breezeway to reduce snowdrifting is acceptable but not necessary, as the pilings are founded by driving into thawed soil.

c) Earthwork and Drainage: During construction, surface water should be directed away from the site. Trenches excavated in these damp silts should stand well. Fine grading will be required to divert water from the building site.

d) Water:

(1) Well: Provide new well (gallery at side of river). Bring top of well to 46 foot elevation, one foot above five year flood water.

(2) Pump: Provide submersible pump in well, power from separate AVEC service to well. Pump to provide 10 gallons per minute at 150 feet total head.

(3) Piping: Pipe from well to school to be 3/4 inch diameter copper in a buried insulated pipe with 5 watts per foot heat tape thermostatically controlled with probes in the line located at the most vulnerable points to freezing.

(4) Water Treatment: Water treatment will be necessary for removal of iron and turbidity. Iron content (6 mg/l) is so high that an ion exchange is not feasible without some form of oxidation prior to this type of treatment. Water quality does not call for chlorination, but in this case the chlorine can be used as an oxidizing agent as well as a disinfectant.

Water from the well will pass through a chlorination chamber into an aeration tank and onto a settling tank. The final step of treatment will be filtration by pumping through a cartridge filter of 10 micron size. Treated water will be stored in a hydropneumatic tank of 300 gallon capacity. Float controls on the settling tank will turn the well pump on and off. Low level controls in the settling tank will close down the system and sound audible alarm and show light in control panel. Operation of the water treatment plant will require considerable training of the school maintenance person. There will be considerable settled sludge to be removed from the settling tank at regular intervals. This sludge will be wasted to the waste water sump and pumped to the disposal lagoon.

(5) Connect Existing Elementary School: If the new source is found to be adequate for more capacity than needed for the new high school, a connection should be made for treated water to serve the existing elementary school.

e) Waste Water:

(1) Type of Treatment: Although there is a possibility of using a septic tank and soil absorption mound (by bringing in gravel for the absorption field), the most feasible solution appears to be a new facultative lagoon. This would be the most simple construction because the site is located mostly above flood water, does not have permafrost in the upper soil layer and silty material is available for the dike construction.

(2) Site: The school site must be expanded to the east to accommodate a sewage disposal lagoon, which will be approximately 1/4 acre in size (150 feet x 75 feet). The construction must be coordinated with the fuel storage facilities in the same general area.

(3) Piping and Pumping: Piping to the lagoon must be insulated and because the site is subject to flooding up to elevation 50 (100 year occurrence), the pipe must be elevated and sewage must be pumped instead of transported by gravity. A sump and pump will have to be located under floor to accommodate this construction. The size of the pumped line can be two inches in diameter to reduce costs. The pipe must be heat taped at 5 watts/foot and of metal (copper or steel) construction so that resistance thawing can be done in case of emergency.

(4) Lining and Fencing: The lagoon must have an impermeable lining embedded in the dike and lagoon bottom. The lagoon must be enclosed with sturdy fencing 6 feet in height with signs warning that entrance to the area is prohibited and that there is danger involved.

(5) Connect Existing Elementary School: A connection to the existing elementary school can be made if a sump pump and insulated line are installed to bring the waste water to the new school system.

f) Solid Waste: No new system is contemplated. Container storage is provided in the new school at a point convenient to load out into a truck. Protection from wind and animals is also provided.

No burning will be done at the school site.

3) STRUCTURAL:

a) Scope of Work: The scope of work under this section is to provide the structural design for the school building or buildings included under this contract, complying with all applicable State and local building and fire codes.

b) Standards: All materials and methods shall conform to the latest rules, regulations, and/or specifications of the following authorities:

American Society for Testing Materials (ASTM)
American Concrete Institute (ACI)
American Institute of Steel Construction (AISC)
American Welding Society (AWS)
National Board of Fire Underwriters (N.B.F.U.)
American Institute of Timber Construction (AITC)
Uniform Building Code (amended by local code) (UBC)
American Plywood Association (APA)

c) Structural Features:

(1) Foundation: Foundations will be timber piles which will conform to the recommendations developed by a subsurface investigation and report made for the site by a qualified soils engineering firm. The piles will be required to resist all vertical and lateral loads imposed on the structure. Pile spacing will be optimized depending on the allowable loading for the pile, the floor plan of the building, and modular sizes for construction materials. Piles will support the building at an elevation above-grade sufficient to thermally protect any frozen material under the building.

The thawing of potential ice lenses or permafrost may lead to settlement of the ground surface under the school. This would create a down-drag on the pile system sufficient to produce failure and/or a low spot which will tend to accumulate water during break-up, resulting in a mire beneath the building.

(2) Floor System: The structural elements of the floor system shall be designed to complement the "warm floor" or "insulated floor" concepts as developed under the architectural section of this criteria. Primary floor framing may be of glu-lam timber beams spanning between pile caps. Fire-resistive requirements limit the use of other materials or truss systems which will be exposed below the structure unless the members are protected by one hour construction.. Wood or nailable steel floor joists may be used to support the plywood floor. The plywood flooring shall support the floor loads and also serve as a diaphragm to distribute the lateral loads caused by wind or seismic loading to the pile foundation system.

(3) Exterior Walls: The exterior walls shall be load bearing with standard wood stud and plywood sheathing construction designed to support roof vertical loads and to resist lateral wind or seismic loading. The plywood sheathing and nailing pattern shall be designed to carry all wall shears caused by lateral loading.

(4) Roof: Roof loads shall be carried by timber or steel open web joists spanning between load bearing walls. Lateral loads at the roof line shall be carried by the plywood roof deck acting as a diaphragm to the exterior shear walls. Structural roof elements shall be designed to complement the "warm" or "cold" roof design as developed in the architectural criteria.

d) Modular Prefabricated Construction: Where economies in construction and freight costs show probable advantages for modular prefabricated construction, stress skin panel design for floor and roof systems shall be considered.

e) Structural Acoustic Insulation: Because of noises transmitted from the gym area through the structural floor system to other areas in the building, designs which would help to isolate the gym floor acoustically from the rest of the building shall be considered.

f) Gymnasium Floor: In the gym area, the design of the floor shall result in a stiff structural system which is adequate for gymnasium activities.

g) Design Live Loads:

Roof, Snow Load:	35 psf
Floor:	
Shop:	100 psf
Classrooms:	40 psf, plus partition
Corridors & Stairways:	100 psf
Office Areas:	50 psf, plus partition loads
Mechanical Room:	100 psf
Restrooms:	50 psf
Gymnasium:	50 psf
Storage:	125 psf
Wind:	UBC, 25 psf Zone
Seismic:	UBC, Zone 1

4) MECHANICAL:

a) General Description: A basis of design for the mechanical requirements of any structure cannot be written without reference to the structure, climate, proposed use and occupancy, availability of utilities, and special requirements of the project.

The project is located at a location which requires a winter design temperature of -40 degrees F., and a summer design temperature of 73 degrees F.

The existing fuel storage tank farm shall be enlarged. Fuel oil shall be piped to a fuel tank at the new school, sized at 500 gallons to supply two furnaces in the building.

Alternate fuels, i.e., wood and coal, are not readily available, and therefore not considered. However, the possibility of "waste heat" from a future on-site generator, or from AVEC, requires the two furnaces to be designed to accept a future heating coil to use the "waste heat" of the generating plant for building heating. This will be done so the oil burners will become "peaking only" or "standby" heating at that time.

b) Heating and Ventilating: Heating and ventilating systems will be designed in accordance with the following data, factors and procedures.

(1) Outside Design Conditions Per Alaska Regional Profiles:

Summer Design Temperatures:
Outside Dry Bulb 73 degrees F.
Outside Wet Bulb 63 degrees F.
Winter Design Temperatures:
Outside Dry Bulb -40 degrees F.
Location:
Latitude 62 degrees North; 50 feet elevation.
Heating Degree Days: 14,500

(2) Interior Design Conditions per ASHRAE Handbook of Fundamentals, 1977 Edition:

Winter:
Inside Dry Bulb 72 degrees F.
Summer (Excluding June, July, and August):
Inside Dry Bulb 75 degrees F.

(3) Calculation Method: Heat gain and loss calculations will be performed utilizing a computer program with factors from the 1967 ASHRAE Handbook of Fundamentals.

(a) Until floor plans are developed to a point where room-by-room calculations can be performed, block heating and cooling loads will be calculated based for four zones based upon four major activity areas:

(1) Multipurpose.
(2) Multipurpose classrooms.
(3) Shop.
(4) Toilets and lab.

(b) Since lighting plans and small appliance loads are not yet developed, an electrical load of 4 watts per square foot will be assumed to include lighting and miscellaneous equipment within conditioned spaces. When specific appliance loads are known, they will be included in the calculations in addition to the 4 watt general load.

(4) Cooling Source:

(a) Outside air shall be used for the cooling source when cooling is required.

(b) Outside air will provide all cooling up to 60 degrees F. outside air temperature and maintain 75 degrees F. inside.

(c) When the outside air temperature is above 60 degrees F. to the summer design of 73 degrees F., the inside temperature will be 15 degrees F. above ambient outside air temperature.

(5) Ventilation:

(a) Ventilation of specific spaces will be in accordance with ASHRAE Standards and 1976 UBC. Classrooms and multipurpose will be provided a minimum of 5 cfm/ person of outside air and a minimum of 25 cfm/person circulated.

(b) Generally, ventilation air for occupied spaces will be taken in from outside via eave vents in the roof into a common OSA intake serving each air handling system. (See Drawing No. 6).

(c) Exhaust hoods will be provided for exhaust air ventilation for special use rooms such as industrial education and science.

(d) Exhaust ventilation system will be through ducts with a velocity not to exceed 1800 FPM. The following areas will be designed for exhaust ventilation at the rates indicated:

	Total Air Changes/Hour
Janitor's Closets	4
Toilets	12

(6) Air Distribution:

(a) Central air system will include furnaces and air ducts to convey conditioned air to each zone. Furnace will consist of filters, oil-fired heating section, fan section, sound isolators, and mixing damper section and controls.

(b) Each zone air system shall be a constant volume, variable temperature warm air heating and ventilation system. The furnaces will be controlled by a room thermostat to vary the temperature of air into the zone to match zone requirements. The air system will allow 100% outside air for cooling when outside temperature is above 60 degrees F. However, full mechanical cooling for "true" air conditioning will not be provided due to lack of full use of facilities during the months of June, July, and August.

(c) The ductwork will be low-velocity galvanized steel rectangular or round ducts and fittings constructed to SMACNA or ASHRAE Standards. The supply air ductwork shall discharge into a supply air floor plenum with perimeter supply air registers. The return air duct at each furnace shall allow future addition of a glycol heating coil to utilize "waste heat" from generator.

(7) Heating Source: The preliminary heating load is estimated at 240,000 BTU/hour at design temperature. Two oil-fired furnaces of 120,000 BTU/hour each have been selected. Ductwork shall be manifolded to allow cross-supplied heated air from other furnaces under emergencies.

(8) Air Filtration: All air in air handling systems will be filtered through renewable media filters rated at 500 FPM velocity and .25" SP loss at 25% average dust spot efficiency.

(9) Automatic Controls: An electric control system will be designed to control heating and air systems.

(a) Electric modulating type controllers will be employed for modulating type motor operated dampers, oil burner controls and room thermostat.

(b) Each zone will have an individual temperature control to control temperature in each respective zone.

(10) Fire Protection:

(a) Heat type detectors will be provided in supply air ducts downstream of filters for all air supply systems to shut down fans when temperature exceeds 150 degrees F.

(b) Automatic fire dampers will be provided in ducts at fire partitions as required by Code and State Fire Marshall.

c) Plumbing:

(1) Sanitary Soil, Waste, and Vent:

(a) The sanitary soil, waste and vent system will serve all the plumbing fixtures throughout the building.

(b) Pipe sizing will be by using the Uniform Plumbing Code flow rates determined by use of the fixture unit schedule.

(c) Piping inside of the building to the connection with the site sanitary sewer will be standard weight cast iron soil pipe with compression-type gasket joints.

(d) Piping will be hubless service weight cast iron soil pipe as required by selected joining method. Joints will be compression-type gasket or stainless steel coupling with T-bolts and neoprene gasket. Galvanized pipe with cast iron drainage fittings or DWV copper with cast copper solder joint drainage fittings may be used for drain and vent piping.

(2) Domestic Water Systems:

(a) Domestic cold water will be used for all normal plumbing uses, such as lavatories, toilets, drinking fountains, etc. Piping for domestic water in the building will be type "L" copper with copper or wrought brass solder fittings. Solder for cold water piping will be 50-50 lead-tin.

(b) Domestic hot water will be generated by a hot water heater.

5) ELECTRICAL:

a) Electrical Load Estimate:

Multipurpose: 1500 sq. ft. @ 3 watts/sq. ft.	4,500
Academic, Resource, Lab: 1750 sq. ft. @ 4 watts/sq. ft.	7,000
Shop: 400 sq. ft. @ 5 watts/sq. ft.	2,000
Supporting Area: 755 sq. ft. @ 2 watts/sq. ft.	1,510
Shop Equipment	4,000
Mechanical Equipment	4,000
	23,010
Estimated Diversity Factor - .8	
Estimated Peak Load - .8 x 23,010	18,400 W
Standby Load (Mechanical + Minimum Lighting)	6,000 W

b) Estimated Annual Electrical Consumption:

School Operation (Nine Months)

Estimated Peak = 18 KW
Estimated Load Factor = .4
KWHR Consumption = 18 x .4 x 8760 x .75 = 47,300 KWHR

Summer Operation (Multipurpose Area Only)

Estimated Peak = 6 KW
Estimated Load Factor = .3
KWHR Consumption = 6 x .3 x 8760 x .25 = 3942 KWHR

Total Annual Consumption = 51,000 KWHR

c) Lighting Levels:

Academic Area, Lab, Resource	70 fc
Multipurpose Area (Not including Academic Area)	50 fc
Shop	70 fc
Restrooms	30 fc
Mechanical/Electrical	20 fc
Maintenance	70 fc
Storage	20 fc
Circulation (Corridors)	20 fc

d) Narrative Description of Electrical Systems:

(1) Standby Generation: 7-1/2 KW skid-mounted diesel generating unit self-contained in weatherproof enclosure. Located outside school.

(2) Power Service: Single phase, 120/240 volt, 100 amp, meter base on building exterior, for underground service.

(3) Power Distribution: Circuit breaker panel with 100 amp main breaker, subfeed to small circuit breaker panel for mechanical equipment with transfer switch to connect to standby generator. Also subfeed to shop panel.

Convenience outlets in surface-mounted raceway 24" above finished floor or above counters in classrooms, multipurpose rooms, labs and shops. Empty raceway in shop for future equipment. Other receptacles in corridors, mechanical room, restrooms, etc. as required.

(4) Lighting: Designed to specified average maintained lumens. Commercial 2' x 4' fluorescent fixtures with flat acrylic diffusers in lab and corridors. Industrial fixtures with metal reflector and wire guards in shop, multipurpose area, and maintenance room. Low-bay mercury vapors chosen for low brightness are used to supplement lighting over academic areas in multipurpose room. Enclosed, gasketed fixtures with damp location label and polycarbonate diffusers in restrooms. Bare lamp fluorescent strip lights in mechanical and storage rooms. Use 40 watt, 48" cool white fluorescent lamps for all fixtures. Exterior lights to be wall bracket type, with 150 watt HPS lamps.

(5) Emergency and Exit Lighting: Emergency lighting in multipurpose area and corridors are to be self-contained units with tungsten-halogen lamps and polycarbonate diffuser, vandalproof construction. Exit lights at all exits and corridor intersections, self-powered type.

(6) Fire Alarm System: Single zone system, with standby battery, Class A wiring. Nonbreak glass pull stations at each exit, smoke detectors in corridor, smoke or heat detectors in all areas. Flashing red lights on interior horns, exterior horn; rotating beacon on roof.

(7) P.A. System: Amplifier with microphone, tape and record player inputs, clustered horns in center of multipurpose area. Microphone jacks at three locations in multipurpose area.

(8) Telephone and TV: Raceways installed for future system.

(9) Grounding System: Bare 2/0 copper conductor around perimeter of school, buried 24", with 1/2" x 8'-0" driven ground rods at 20' intervals. System bonded to metallic cold water piping.

B.3 SCHEMATIC DESIGN

b) SCHEMATIC DRAWINGS:

The EXAMPLE PROCESS SCHEMATIC DESIGN is illustrated in the following attached drawings:

1) Vicinity Plan
2) Village Plan
3) Site Plan
4) Floor Plan, Scheme "A", One-story
5) Building Section, Scheme "A", One-story
6) Environmental Building Section, Scheme "A", One-story
7) Floor Plan, Scheme "B", Two-story
8) Building Section, Scheme "B", Two-story

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PAGE 1

Example Process: Schematic Design

Kuchpu Secondary School

Kuchpu, Alaska

VICINITY PLAN

1" = 1 MI

II. Methodology

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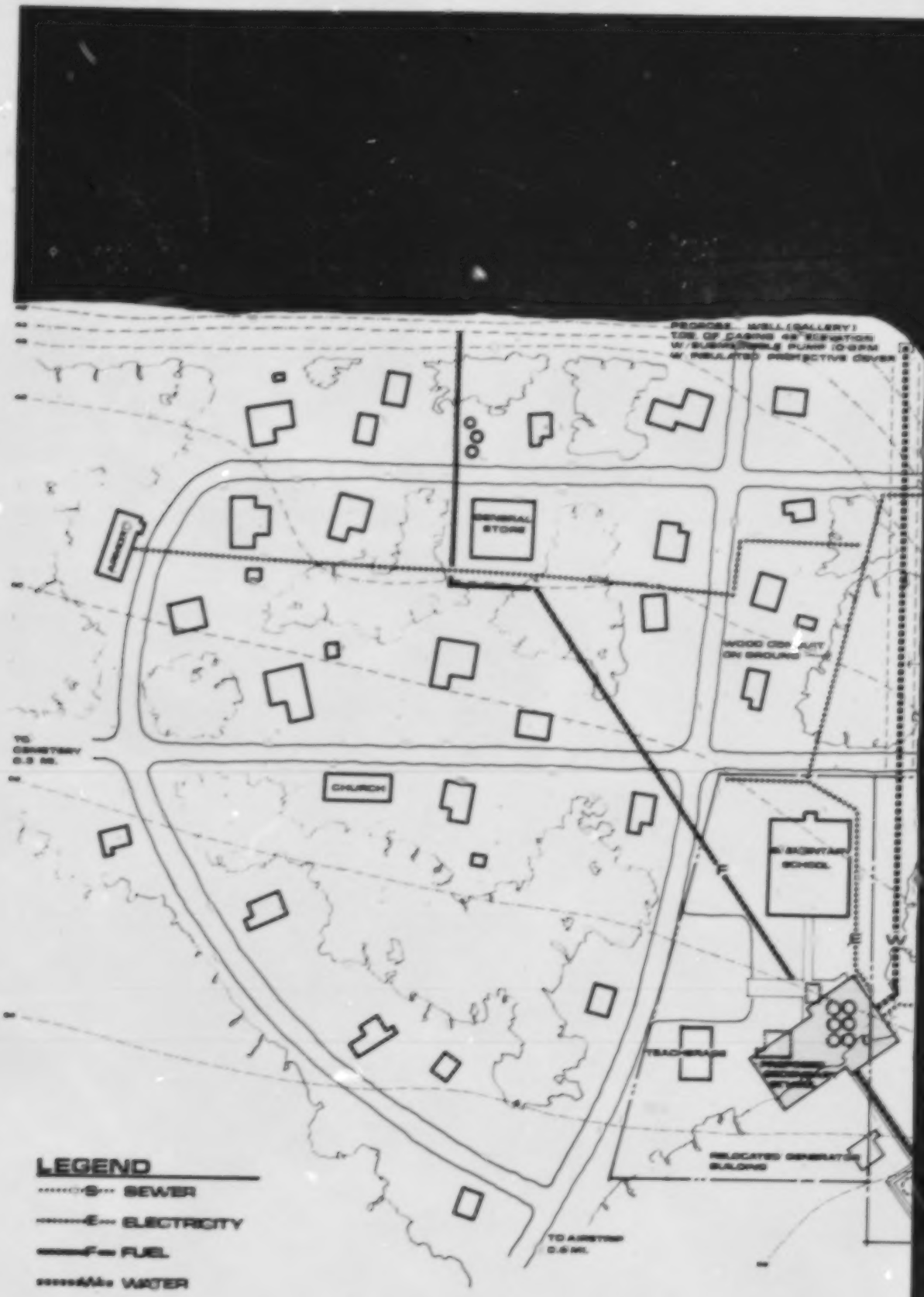

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VILLAGE & UT

PAGE 1

ILITY PLAN

PAGE 2

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Example Process: Schematic Design
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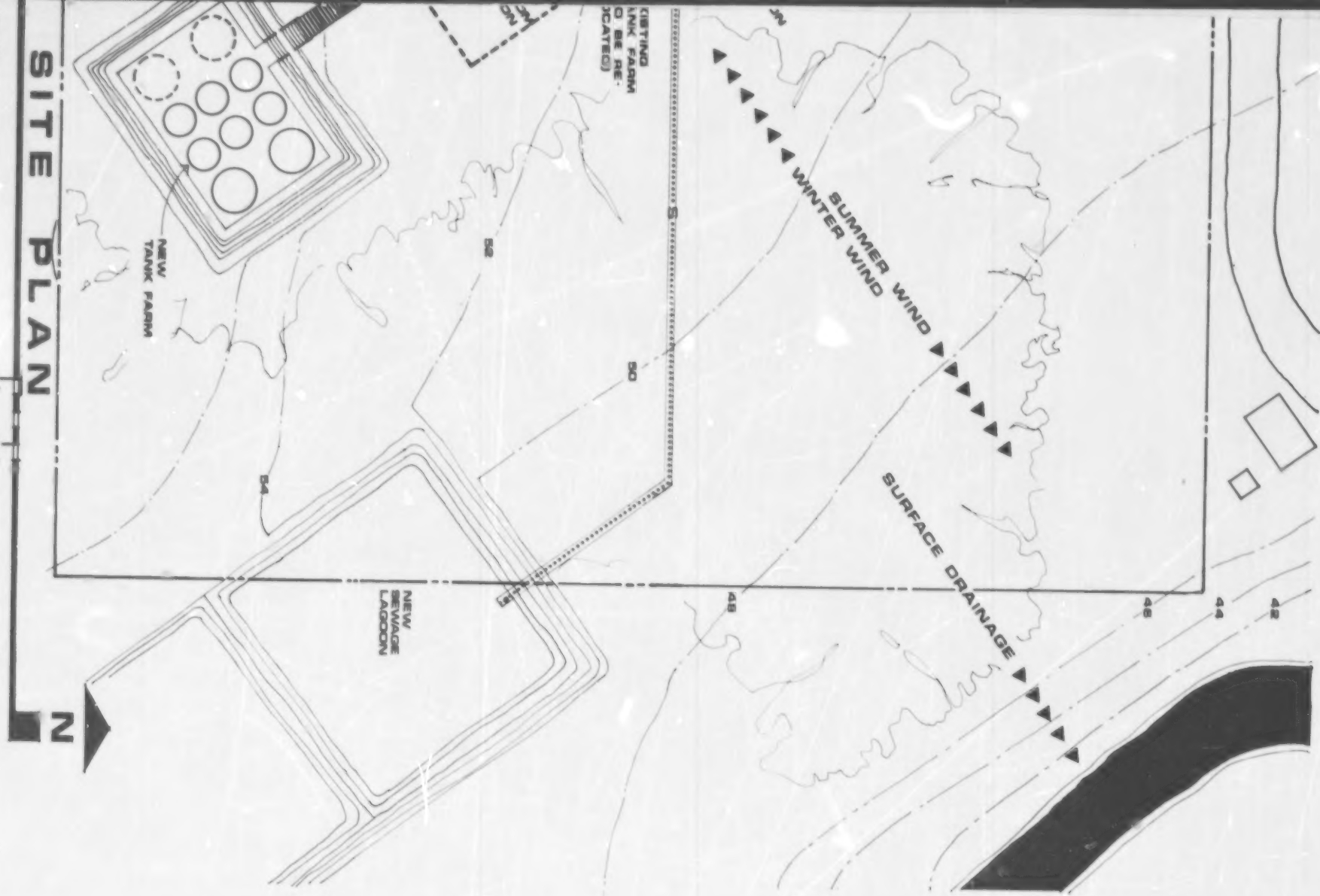
Kuchpu, Alaska
VILLAGE & UTILITY PLAN

N

EXIST-
ING
METERS
COMMUNITY
EXISTING
ELEMENTARY
SCHOOL
EXISTING
DAY TANK
NEW
GRAVEL
PARKING
AREA
NEW
BOARD-
WALK
STAIR
RAMP
OUTHOUSE
(TO BE
REMOVED)
TO AIRSTRIP
TO RIVER
EXISTING
GENERATOR
BUILDING
EXISTING
ANTENNA
EXISTING
TEACHER
HOUSING
NEW
HIGH
SCHOOL
MULTIPURPOSE
EXPANSION
RELOCATED
GENERATOR
BUILDING
SUN
WINTER
SUMMER

SITE PLAN



sheet 3

Example Process: Schematic Design

Kuchpu Secondary School

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SITE PLAN 8·1·78

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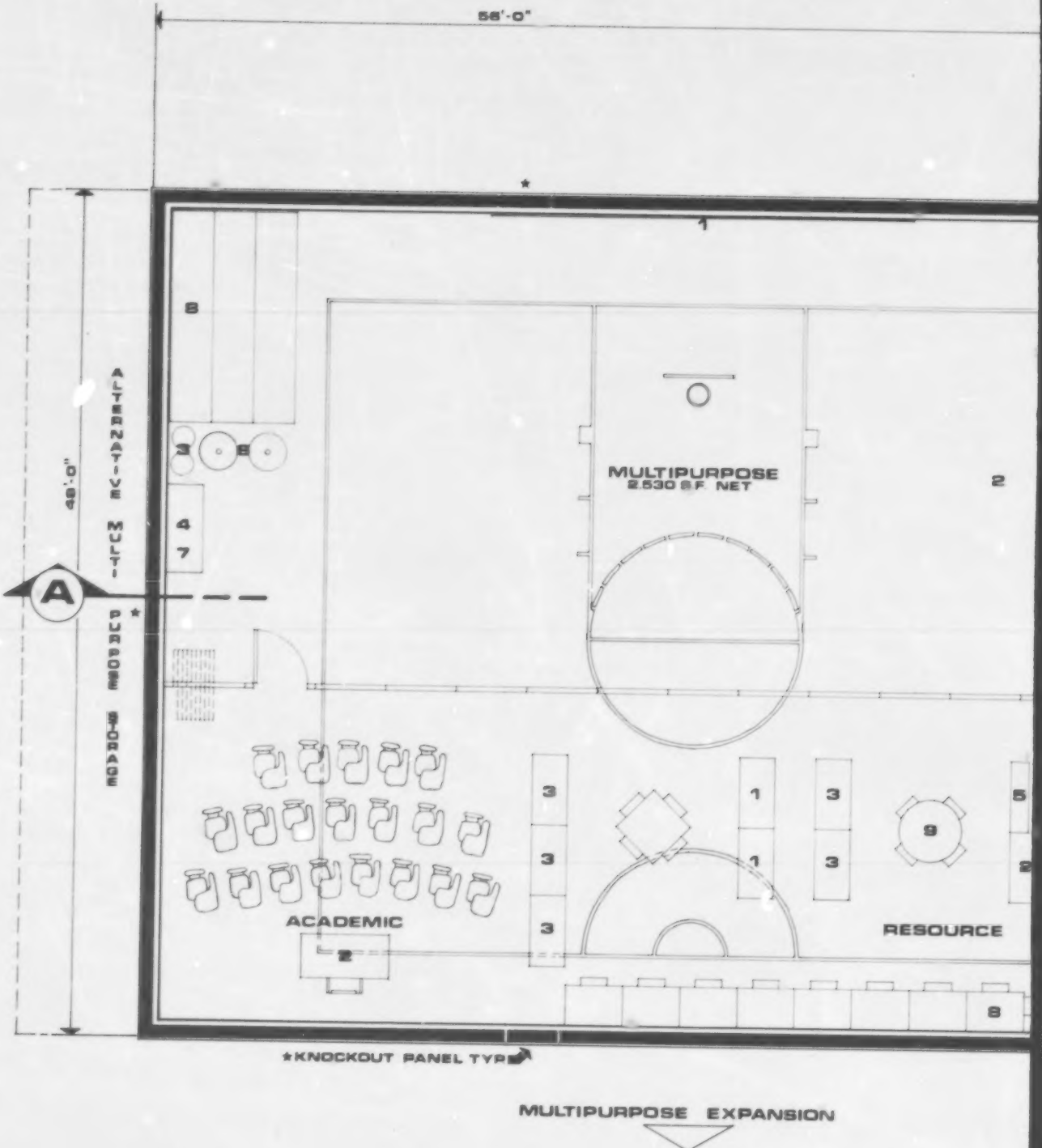
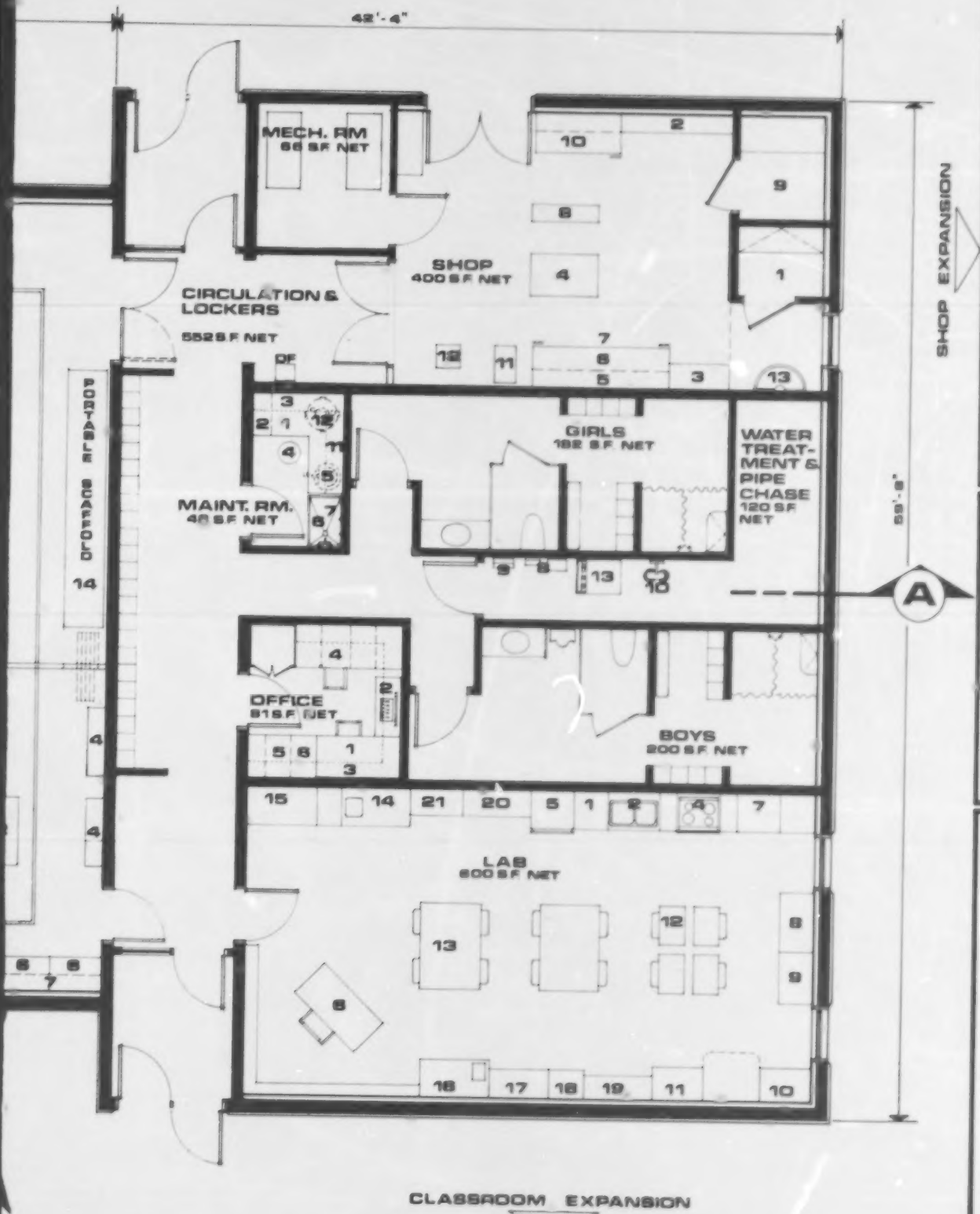


MAIN LEVEL FLOOR PLAN

SCHEME A

N

0' 5'



MAIN LEVEL FLOOR PLAN

SCHEME A

☆NOTE: TO IDENTIFY EQUIPMENT, SEE CONCEPTUAL LAYOUTS IN VOLUME I, 4.23.

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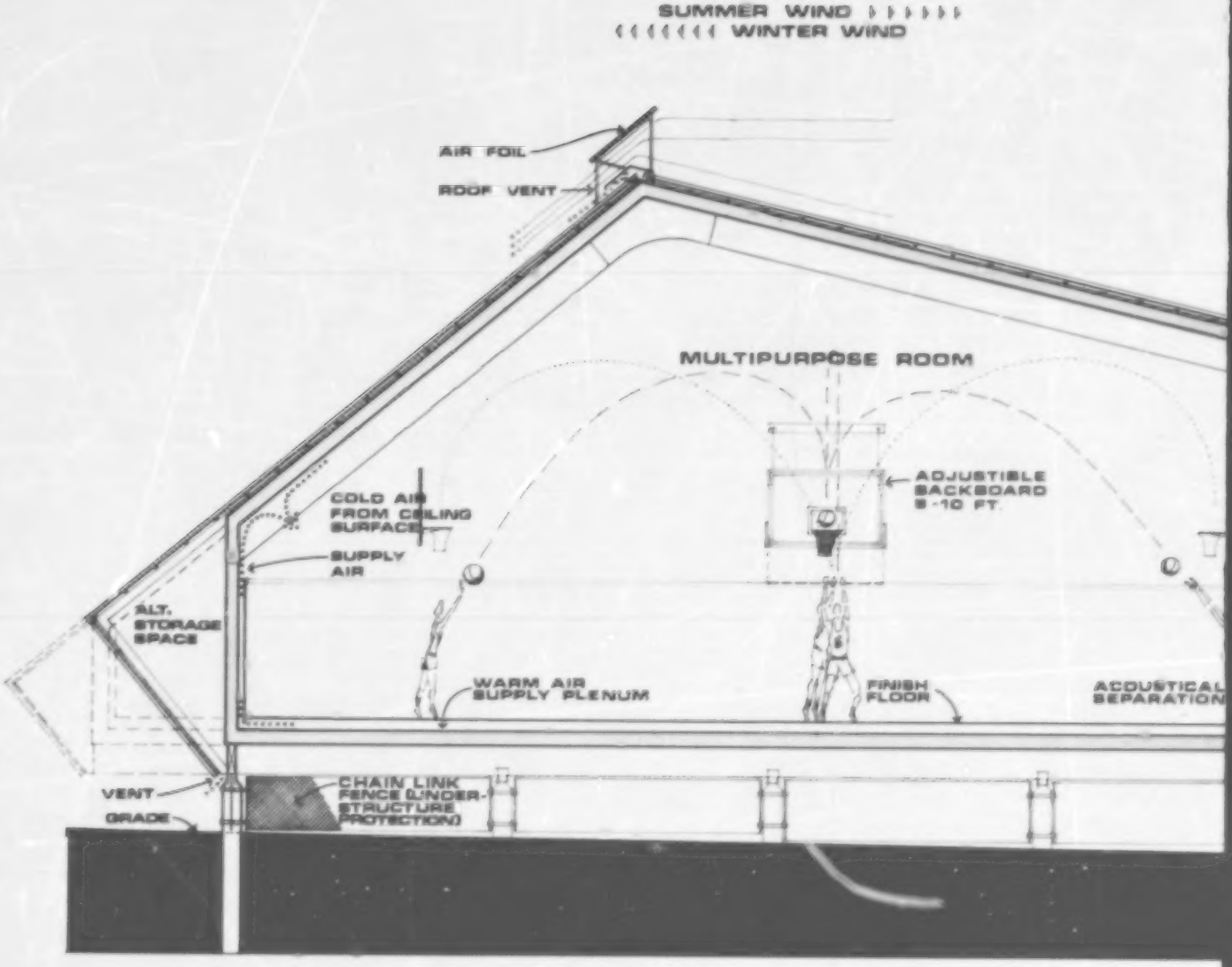
8-1-78

FLOOR PLAN A

sheet 4

PAGE 2



BUILDING SECTION A A

SCHEME A

BUILDING SECTION A A

SCHEME A

0' 5'

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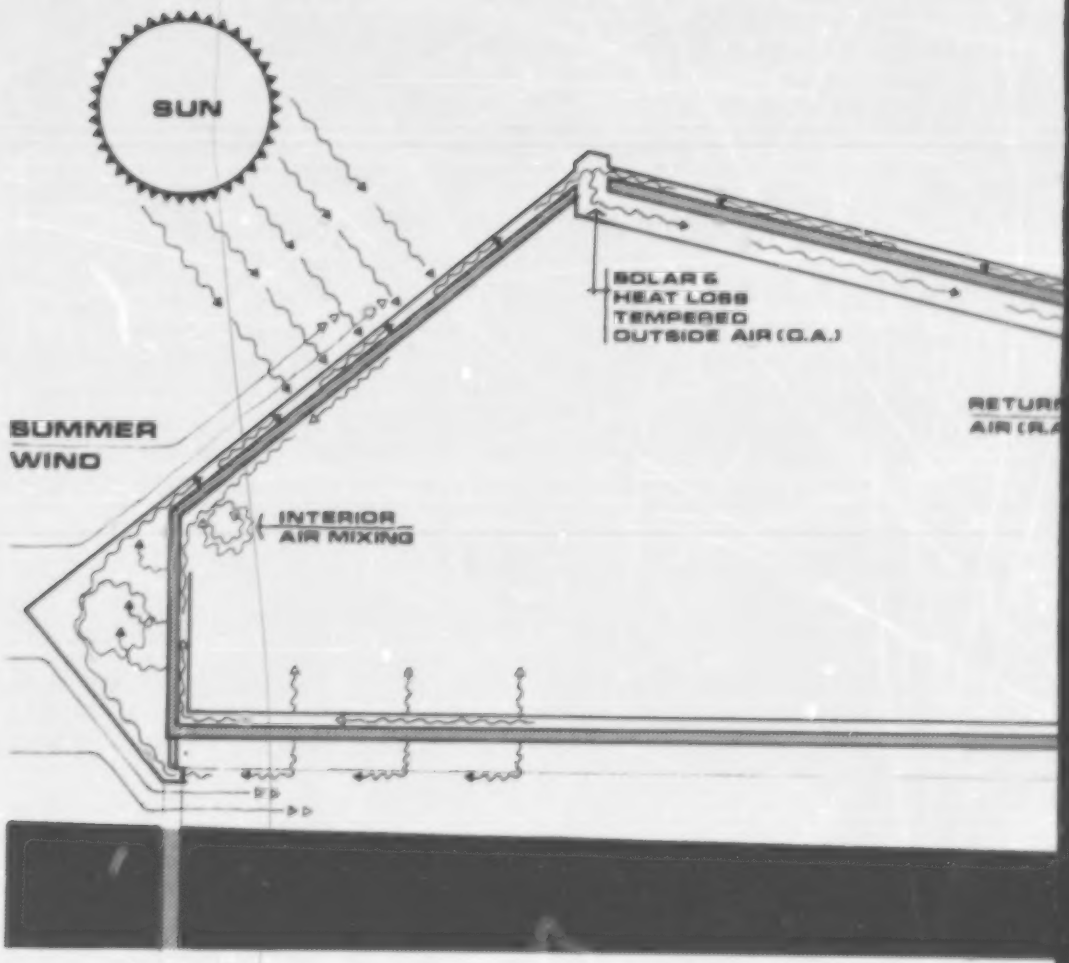
BUILDING SECTION 8-1-78

sheet 5

PAGE 2



ENVIRONMENTAL BUILDING SECTION

PAGE 1

ENVIRONMENTAL BUILDING SECTION

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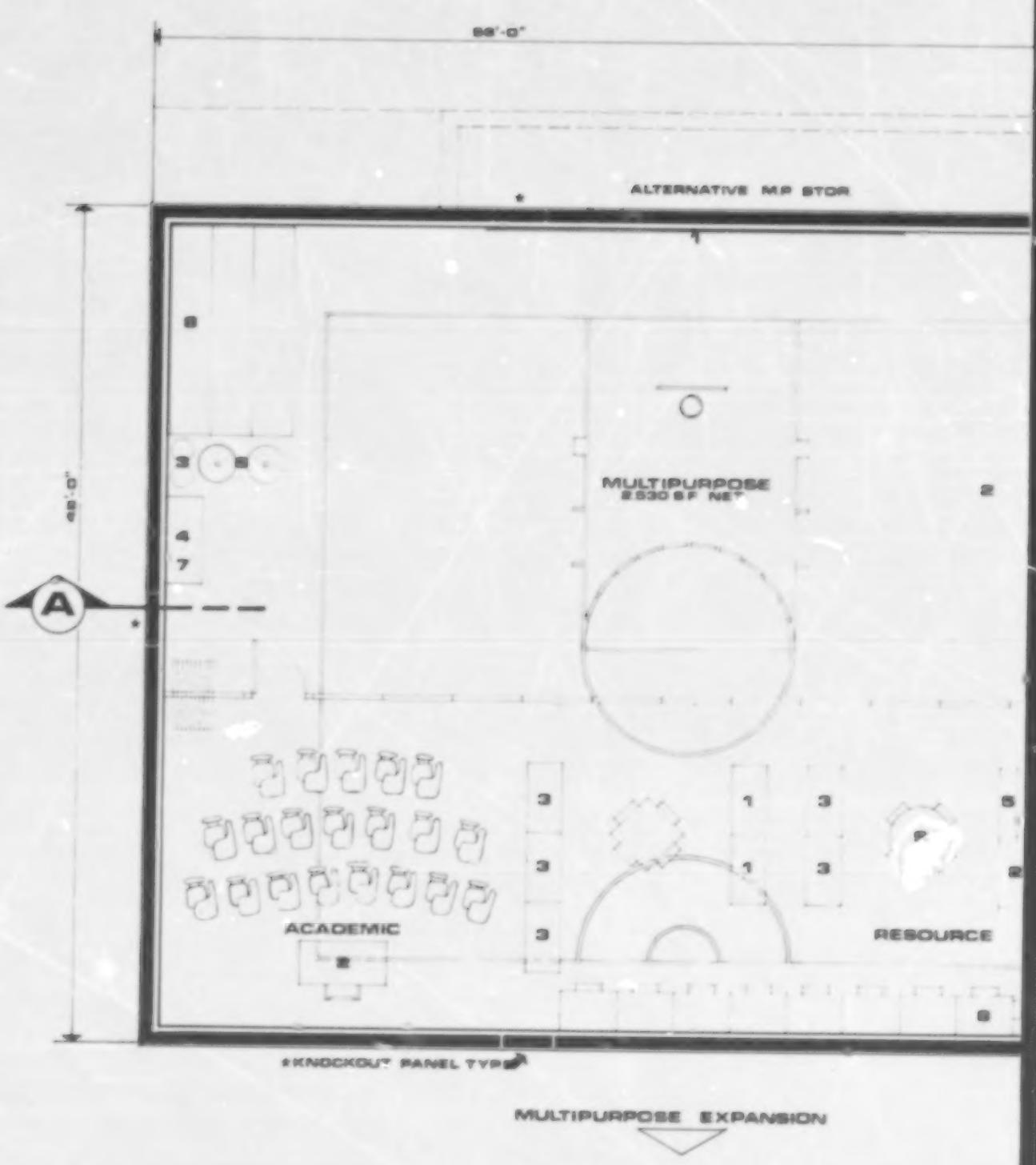
Kuchpu, Alaska

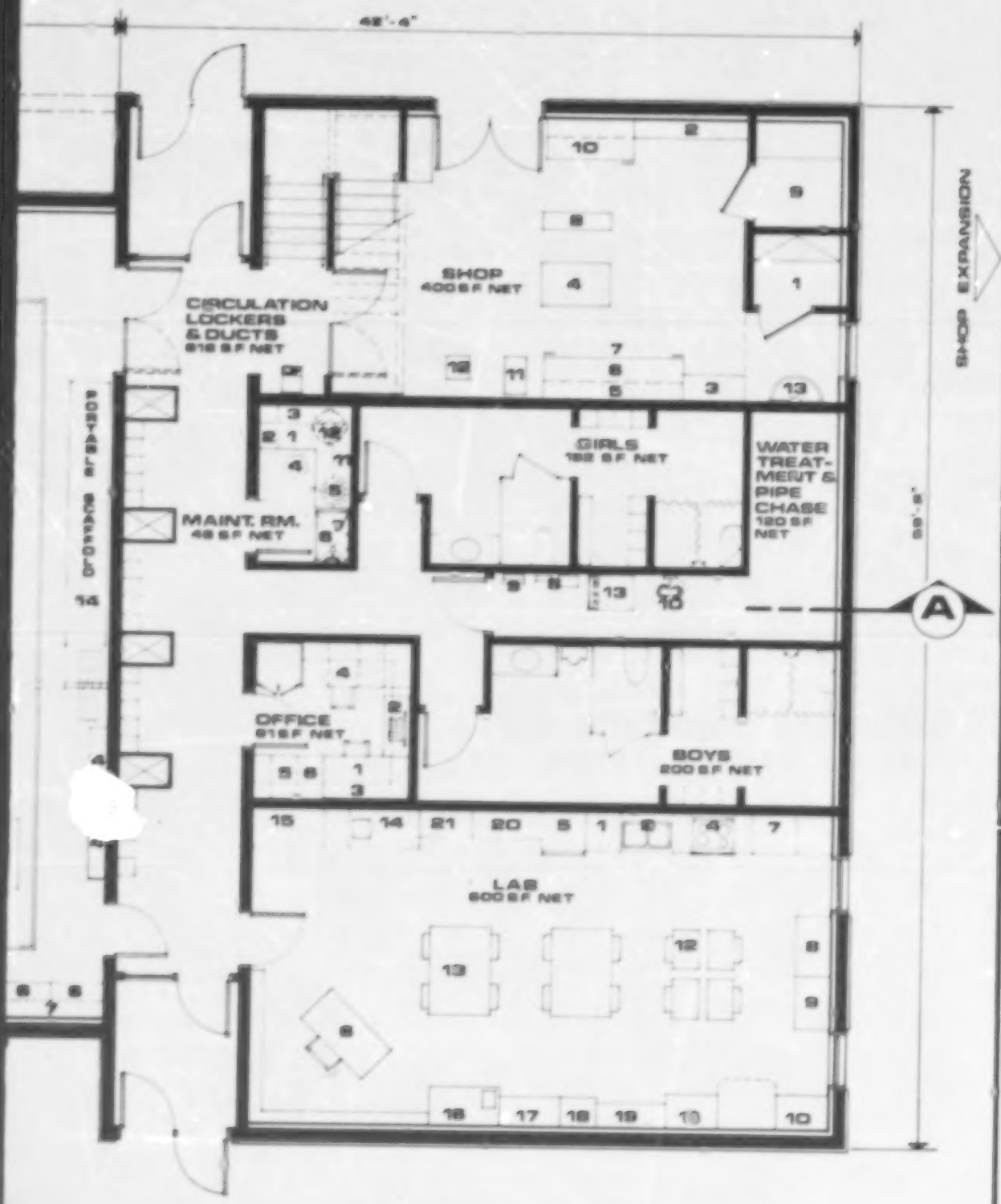
ENVIRONMENTAL SECTION

Sheet 6



MAIN LEVEL FLOOR PLAN

SCHEME B



CLASSROOM EXPANSION

MAIN LEVEL FLOOR PLAN

☆NOTE: TO IDENTIFY EQUIPMENT, SEE CONCEPTUAL LAYOUTS IN VOLUME I, 4.23.

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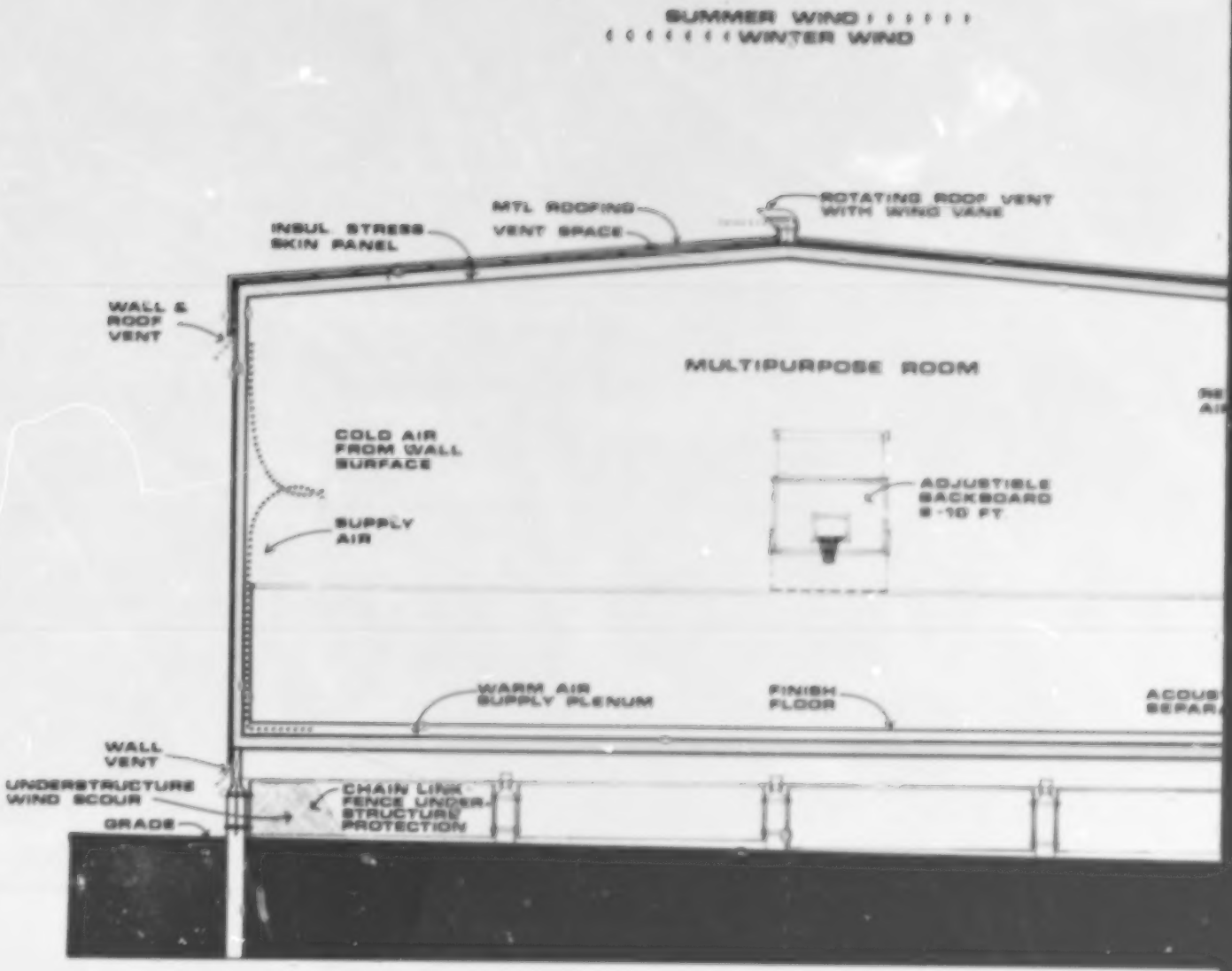
FLOOR PLAN B
8-1-78

sheet 7

PAGE 2



BUILDING SECTION AA

SCHEME B

BUILDING SECTION AA

SCHEME B

0' 8'

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BUILDING SECTION
8-1-78

Sheet 8

PAGE 2

B.3 SCHEMATIC DESIGN

c) COMPARISON OF TWO PROTOTYPE SCHEMATICS:

The following are comparisons between two schematic designs, Schemes "A" and "B", with regard to area analysis and estimated construction costs.

1) Analysis - Scheme "A", One-story:

The prototype school schematic, Scheme "A", is within six percent of providing for the educational program as specified by the DOE guidelines and as programmed in Section 4.2. Within the assignable space of the prototype is included an administrative office area and a flexible-use, 2,530 square foot multipurpose room, of which 1,000 square feet is also used for classrooms.

The major area deviations between the DOE guidelines and Scheme "A" is in the allocation for supplementary or unassignable space. The design of the prototype began with the allocation of space for the educational program and then added the minimal amount of supplementary space needed to allow this facility to function. This included space for general storage (which utilizes attic space) and site utilities, i.e., water treatment and standby power generation. Sewage in this facility is pumped to a lagoon and did not require floor area.

Wall thickness accounted for 12 percent of the gross floor area of the building which seems high, but is a reality in the Arctic.

By subtracting the following items out of the total gross area of the prototype, we can identify where the deviation between the DOE guidelines and the prototype occurred:

Office	81 s.f.
Water Treatment	120 s.f.
Power Generation	90 s.f.
General Storage	320 s.f.
Wall Thickness	616 s.f.
TOTAL	1,221 s.f.

Note that the total deviation between the prototype and DOE Guidelines was 1,250 square feet. If these above items had been adequately provided for in the guidelines, the prototype would be within 23 square feet of the desired total.

SPACE SUMMARY - SCHEME "A", ONE-STORY

SECONDARY SCHOOL - 11-20 STUDENTS

DOE GUIDELINES	S.F.	PROTOTYPE - SCHEME "A"	S.F.	DEVIATION + AMOUNT OVER OR - BELOW DOE GUIDELINES S.F.	
Classrooms	800	Academic	500		ASSIGNABLE
	- 1,700	Lab	600 - 1,600	+ 300	
Library Media	900	Resource	500	- 400	
Office	0	Office	81	+ 81	
Industrial Ed.	400	Shop	400	0	
Multipurpose	1,200	Multipurpose	1,430	+ 230	
Total	3,300		3,511	+ 211 (6% Over)	
SUPPLEMENTARY SPACE (Undefined by DOE)		SUPPLEMENTARY SPACE (as Defined by Prototype)			
		Restroom/Locker	382		
		Mechanical	66		
		Circulation	552 (10.6% of Ground Floor Area)		
		Maintenance Room	48		
		Wall Thickness	616 (12% of Ground Floor Area)		
		General Storage	320 (Use of Attic)		
		Water Treatment	120 (Site Utilities)		
		Power Generation	90 (Separate Bldg.)		UNASSIGNABLE
Total	1,155 (27% of Gross)	Total	2,194 (39% of Gross)	+ 1,039	
GROSS TOTAL	4,455	GROSS TOTAL	5,705	TOTAL DEVIATION + 1,250	

2) Analysis - Scheme "B", Two-story:

The prototype school schematic, Scheme "B", is within six percent of providing for the educational program as specified by the DOE guidelines and as programmed in Section 4.2. Within the assignable space of the prototype is included an administrative office area and a flexible-use, 2,530 square foot multipurpose room, of which 1,000 square feet is also used for classrooms.

The major area deviations between the DOE guidelines and Scheme "B" is in the allocation for supplementary or unassignable space. The design of the prototype began with the allocation of space for the educational program and then added the minimal amount of supplementary space needed to allow this facility to function in rural areas. This included space for general storage (which utilizes the second level space) and site utilities, i.e., water treatment and standby power generation. Sewage in this facility is pumped to a lagoon and did not require floor area.

The basic floor plans of Schemes "A" and "B" are almost identical. The major difference between the two schemes is that, in Scheme "B", the roof slope allows for the second level to be usable space. As demonstrated by the cost comparisons, where a high mass such as the multi-purpose room exists, the additional cost of constructing usable space on a second level above other occupied areas is minimal. The second floor area may initially be used to house building mechanical and general storage. With the addition of a second stairway, this area may be used for classrooms. This space may be of great benefit in villages where a growth in student population is expected. To accommodate handicap requirements in a two-level school, there are two options:

a. Do not offer educational program on inaccessible level that is not available on accessible level.
b. Provide a chairlift on a stright run stair, or install a handicap lift.

While this efficient use of building volume decreases the total cost per square foot and increases expansion potential, the additional area will inflate the percentage of DOE unassignable space.

SPACE SUMMARY - SCHEME "B", TWO-STORY

SECONDARY SCHOOL - 11-20 STUDENTS

DOE GUIDELINES	S.F.	PROTOTYPE - SCHEME "B"	S.F.	DEVIATION + AMOUNT OVER OR - BELOW DOE GUIDELINES	S.F.	
Classrooms	800 - 1,700	Academic	500			ASSIGNABLE
		Lab	600 - 1,600	+	300	
Library Media	900	Resource	500	-	400	
Office	0	Office	81	+	81	
Industrial Ed.	400	Shop	400		0	
Multipurpose	1,200	Multipurpose	1,430	+	230	
Total	3,300		3,511	+	211 (6% Over)	
SUPPLEMENTARY SPACE (Undefined by DOE)		SUPPLEMENTARY SPACE (as Defined by Prototype)				
		Restroom/Locker	382			
		Mechanical	250 (Second Level)			
		Circulation	618 (11% of Ground Floor Area)			UNASSIGNABLE
		Maintenance Room	48			
		Wall Thickness	716 (9% of Gross Floor Area)			
		General Storage	2,175 (Second Level)			
		Water Treatment	120 (Site Utilities)			
		Power Generation	90 (Separate Bldg.)			
Total	1,155 (27% of Gross)	Total	4,399 (56% of Gross)		+ 3,244	
GROSS TOTAL	4,455	GROSS TOTAL	7,910	TOTAL DEVIATION	+ 3,455	

5) Comparative Construction Cost Estimate:

The following five pages contains a construction cost estimate that compares costs between Schemes "A" and "B".

Project: KUCHPU SECONDARY SCHOOL COST COMPARISON **Date:** July 31, 1973 **Sheet No.** 1

This estimate is based upon a lump sum contract with an assumed immediate construction start, and an eight (8) month construction period. A competitive bidding situation is assumed.

The two alternate school structures were compared. It was assumed the added weight of the two story structure did not appreciably influence foundation design. Also, since the increase in building volume is not too great (112,200 ft.^{3} versus 92,350 ft.^{3}), it is assumed the same furnaces will be used but will only run more often.

Cost Summary:

Two Story:	- building only	$1,053,070
	total construction	1,384,840
Single Story:	- building only	$ 890,970
	total construction	1,223,340

Note that this estimate includes all furnishings and educational equipment as listed in the building program, Section 8, for the 11-20 enrollment group size.

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Revised July 31, 1973

Project: Kuchpu Secondary School (two story)

Cost Plan/Cost Check No:

Date: July 31, 1978

Sheet No: 2

Uniformat Element	Amount $	Total Cost $	Rate $/SF Floor Area	%	Comments
[illegible]		87,500			
011 – Standard foundations	---				
012 – Special foundation conditions	87,500				
[illegible]		---			
021 – Slab on grade	---				
022 – Basement excavation	---				
023 – Basement walls	---				
[illegible]		143,480			
031 – Floor construction	92,000				
032 – Roof construction	49,940				
033 – Stair construction	1,540				
[illegible]		132,150			
041 – Exterior walls	126,670				
042 – Exterior doors and windows	5,480				
[illegible]		15,660			
[illegible]		102,900			
061 – Partitions	25,650				
062 – Interior finishes	37,250				
063 – Specialties	40,000				Movable Partition - Multipurpose Rm.
[illegible]		---			
[illegible]		125,739			
081 – Plumbing	71,160				
082 – HVAC	53,480				
083 – Fire protection	1,090				
084 – Special mechanical systems	---				

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Project: Kupchu Secondary School (two story)

Cost Plan/Cost Check No:

Date: July 31, 1978

Sheet No: 3

Uniformat Element	Amount $	Total Cost $	Rate $/SF Floor Area	%	Comments
		99,600			
091 – Service and distribution	41,730				
092 – Lighting and power	49,050				
093 – Special electrical systems	8,320				
		341,050			
Net Building Cost		994,720			
		123,790			
111 – Fixed and movable equipment	)				
112 – Furnishings	) 123,790				
113 – Special construction	)				
		202,980			
121 – Site preparation	63,370				
122 – Site improvements	35,410				
123 – Site utilities	104,200				
124 – Off-site work	---				
		---			
131 – Design					
132 – Escalation					
133 – Construction					
Total Estimated Construction Cost (Base Bid)		1,384,480			Floor Area = 7,739 SF Cost/SF = $178.90

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Project: Kupchu Secondary School (Single Story)

Cost Plan/Cost Check No:

Date: July 31, 1978

Sheet No: 4

Uniformat Element	Amount $	Total Cost $	Rate $/SF Floor Area	%	Comments
01 – Foundations		64,150			
011 – Standard foundations					
012 – Special foundation conditions	64,150				
02 – Substructure		---			
021 – Slab on grade	---				
022 – Basement excavation	---				
023 – Basement walls	---				
03 – Superstructure		154,240			
031 – Floor construction	81,780				
032 – Roof construction	72,460				
033 – Stair construction	---				
04 – Exterior closure		68,450			
041 – Exterior walls	62,970				
042 – Exterior doors and windows	5,480				
05 – Roofing		15,360			
06 – Interior construction		99,120			
061 – Partitions	24,770				
062 – Interior finishes	34,350				
063 – Specialties	40,000				Movable Partition - Multipurpose Rm.
07 – Conveying systems		---			
08 – Mechanical		39,910			
081 – Plumbing	50,880				
082 – HVAC	38,250				
083 – Fire protection	730				
084 – Special mechanical systems	---				

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U2

Project: Kuchpu Secondary School (Single Story)

Cost Plan/Cost Check No:

Date: July 31, 1978

Sheet No. 5

Uniformat Element	Amount $	Total Cost $	Rate $/SF Floor Area	%	Comments
09 – Electrical		71,210			
091 – Service and distribution	29,840				
092 – Lighting and power	35,070				
093 – Special electrical systems	6,300				
10 – General conditions and profit		299,180			
Net Building Cost		821,620			
11 – Equipment		125,390			
111 – Fixed and movable equipment	)				
112 – Furnishings	) 125,390				
113— Special construction	)				
12 – Site work		202,980			
121 – Site preparation	63,370				
122 – Site improvements	35,410				
123 – Site utilities	104,200				
124 – Off-site work	---				
13 – Contingencies					
131 – Design					
132 – Escalation					
133 – Construction					
Total Estimated Construction Cost (Base Bid)		1,223,340			Floor Area = 5,534 SF Cost/SF = $221.06

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